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THE

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AMERICA, ENGLAND, AND GERMANY AS ALLIES FOR THE OPEN DOOR.

By Hon. John Barrett, Late U. S. Minister to Siam.

II.—THE ENGINEERING AND INDUSTRIAL INTERESTS AT STAKE.

HAVING devoted my article in the preceding issue of THE ENGINEERING MAGAZINE to a review of the material and political conditions of China to-day, we can turn to the consideration of China's material possibilities which especially appeal to an engineering constituency. The size of the country, which naturally is a primary consideration, is, in the matter of area, to be viewed from two standpoints: one, that of China proper, or the eighteen provinces forming a compact whole by themselves, and the other of China and her dependencies making the extent more than double that of China proper. According to the estimates of Lord Charles Beresford, the former has an approximate extent of 1,550,000 square miles, and the latter of 4,300,000 square miles. The largest individual province, or state, of China proper is Szechuan, which has, according to Lord Charles Beresford, 218,534 square miles and a population of 45,500,000. It is, moreover, the most interior province of China proper, and seems to possess the greatest variety of material resources. At the present moment English and French companies are competing with each other for the control of the wealth of this great state. It is said to possess resources of coal, iron, and copper unsurpassed in the world, while within its limits are also found silver, lead, salt, and lime. Added to these are the great surface staples of silk and opium, aside from the lesser and more common agricultural products. Trunk railways must soon connect this inland empire with

Lord Kitchener is quoted as having said, at the opening of the Albara bridge: "Where Englishmen failed. I am delighted to find that our cousins across the Atlantic stepped in. The opening of this bridge to-day is due to their energy, ability, and the power they pos-

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Shanghai and Hong Kong on the east, and with Rangoon and Calcutta on the southwest. When it is understood that there has practically been no development yet of this wonderful province, which is only one small part of China, some conception of China's possibilities may be framed in the layman's mind.

Turning from the largest to the smallest, we have the province of Chekiang, which lies with its full eastern coast line on the North China Sea, just below the mouth of the Yangtze River. Though small in Chinese comparison, it has a population of 10,000,000 and an area of 38,000 square miles. According to Archibald Colquhoun, "Chekiang is renowned alike for its fertility, its forests and fruit trees, its populous towns, and its salubrious climate. Hangchau, the capital, is one of the finest towns in the Empire, and was described by Marco Polo, who visited it in 1286, as 'beyond dispute the noblest in the world.'" When we consider that the conditions throughout this Empire are practically the same as those of one thousand years ago, then we realize what there remains to be done according to the methods of this modern age.

There is no better way to be convinced of the importance, not only of China but of the entire far east, than to study carefully a map of that section. The remarkable coast line that reaches right away from Singapore to Vladivostock, for 4,500 miles, has a variety of conformation formed by the waters of oceans, seas, gulfs, bays, harbors, inlets straits, and channels, which has no counterpart in any other portion of the world. In this mingling of mainland, capes, peninsulas, promontories, and groups of islands, with the separating bodies of water, there are opportunities for the development of commerce and trade which those unacquainted with the geography and resources of the far east would never for a moment appreciate. Already the foreign trade of eastern and Pacific Asia amounts to over $900,000,000, which measures the buying and selling in foreign exchange of 500,000,000 people. This total can only represent a small degree of what the future will show. The commerce of 500,000,000 people must, as they come into closer contact and association with foreign nations, reach, in the comparatively near future, to billions of dollars, if we can take Japan's experience as a criterion. With a population of 40,000,000, she has a

sess in so marked a degree of turning out work of this magnitude in less time than it can be done anywhere else." The Sirdar's words reflect the perception which is daily growing clearer to the broadest and soundest thinkers, that the newly-opened places of the world need, for their development, the federated efforts of all the great nations. And in this spirit Mr. Barrett appeals, through THE ENGINEERING MAGAZINE, to the engineering and industrial world to set aside narrow and short-sighted jealousy and prejudice and cooperate for one great end, for the common good. THE EDITORS.

foreign trade of $225,000,000, and yet in 1875 it amounted to only $47,000,000. China's foreign commerce is valued at $250,000,000. Placing her population at the lowest estimate of 250,000,000, we have evidence that this trade is only in the infancy of its development. Japan's foreign commerce averages about $5.50 per man, while that of China averages only $1; if we make the possible ratio the reasonable figures of three to one, we have a foreign commerce for China of $750,000,000. It is sometimes contended in this connection that China is too poor to buy, and that she has not sufficient to sell to increase her purchasing power. This argument, however, is only advanced by those who have not made a careful study of China's resources. When the great latent wealth of her interior is developed, and when railroads bring her products to market and allow that exchange and intercourse which Japan is now experiencing, it will be found that China will have abundant buying capacity, and sufficient products to sell and meet the demands of the outer world.

According to the statistics of America's foreign trade just published, we find that the United States exported to Asia and Oceanica during the fiscal year ending June, 1899, products to the value of nearly $80,000,000, or an increase over 1897 of nearly $20,000,000, and nearly $14,000,000 over 1898. The major portion of these exports went to Asiatic countries. At this rate of increase, with the expanding influence of control of the Philippines, and with the awakening to the opportunities in China, Japan, Siam, Corea, Siberia, as they have never been realized before, these figures should soon pass the $100,000,000 mark, and go on, within the next two decades, to $200,000,000 or $250,000,000. In the same year the United States purchased from Asia and Oceanica products valued at nearly $134,000,000. The United States have, therefore, a balance of trade against them of over $50,000,000. This alone should be a sufficient incentive for extraordinary endeavor to develop the market.

The field of exploitation for engineers is, however, one of the most interesting and possibly the most extensive. First, in locating and opening up China's great latent resources of iron, coal, copper, lead, silver and gold; second, in the construction of railways, both trunk and tributary lines, of lesser electric railways, of bridges, buildings, and of all kinds of structures that accompany the building of railways; third, in the control and opening up of waterways, improving rivers, removing bars, dredging canals and channels, building dykes, restraining the vast floods of overflowing streams like the Yellow River, introducing systems of irrigation; fourth, in providing the

great cities of China with methods of sanitation, with waterworks, with electric lights, railways and telephones, in extending telegraphic and telephonic systems throughout the Empire, in erecting and managing factories, in building ordinary roads between common points of population and importance; fifth, and at home, in planning to carry out all of these enterprises, gigantic and small, in designing and making the needed equipment, the materials of structure, the supplies for railways, the tools that will be required—in all these and in many other ways the engineers of America, England, and Germany, will have an unprecedented opportunity in Asia to show their ability, and exercise their strong influence for the opening up of a great nation and a mighty people to the civilization, commerce, and methods of the modern European and American world.

In this competition which must go on, I do not fear for the part American engineers will play, if they will only appreciate the opportunity and strive to improve it before it is too late. Many of them have already gone into this field and done extraordinary work. Possibly the most notable recent illustration of what a skilful and persistent American engineer can do is the work of Gen. W. Barclay Parsons,* who has so recently crossed through the southern part of China from Hankow to Canton, and successfully concluded his responsible mission, overcoming obstacles and removing difficulties which would have frightened most men from undertaking the journey. He had opposed to him not only native prejudice, but the influence and, in some respects, unfair competition of some European agents. Towards one and all he pursued the same dogged, but tactful, policy, and accomplished his purpose, which makes him rank among the foremost engineers of America. His example is one which others can afford to follow. In this connection it is well to note one or two other points showing the influence of the American engineer. The chief adviser of Sheng, who is at the head of Chinese railway administration, is another distinguished American railway engineer, Capt. Watson W. Rich. In Corea, the first important railway from Chemulpho to Seoul, and the first electric railway in Seoul, have been built by American engineers. In Siam, the most prominent railway engineer during the last few years has been Mr. Lawrence E. Bennett, an American, who not only had important connections with the Bangkok-Korat railway, but was the moving influence and concessionaire who planned

*Gen. Parsons is preparing for THE ENGINEERING MAGAZINE a discussion of the opening for engineering and railway development in China, based upon the studies made during his recent trip. THE EDITORS.

and managed Bangkok's excellent electric-light system, which is now under the charge of Mr. George C. Holberton, another American. The electric street car line in Bangkok was also constructed by American engineers, and the chief stockholder, after the king, was an American, Dr. T. H. Hays.

Possible railway construction, which appeals more to the engineer than any other class of projects, is a most fascinating subject of study. When it is remembered that in that vast empire of 4,000,000 square miles, and possibly 300,000,000 people, there are not over 350 miles of completed running railways, it is appreciated that the opportunity can be called almost unlimited. The location of the cities of China, the distribution of centres of population, and the conformation of the surface of the land, all point to liberal extension of railways. With great starting points such as Canton or Hong Kong on the south, Shanghai on the east central coast, and Tien Tsin and Peking on the north, and with such objective points as Hankow in the heart of China, Chungking in the far west—several thousand miles of trunk lines are already needed and in sight, as it were, with a sure return on the investment, provided, of course, conditions of government, law, and order are favorable. If these trunk routes are planned and carried out, there must be numerous tributary lines, which will mean as many thousand miles more. Aside from these are the possibilities of early connections between the English railway systems of Burma and India and those projected in China on the west; between the growing system in French Tongking and that proposed in China on the south; and, finally, between the system already started in the north and that of Russia extending right away through Siberia and Manchuria. Germany also has plans for railways in Shantung to the west, connecting with another proposed trunk road along the line of the Grand Canal from Peking to Chinkiang and Shanghai, which is considered by experts to be one of the best routes in all China for freight and passengers. The railway construction planned for the near future in China calls for an investment of more than $100,000,000.

The waterways of China, to which I have made partial reference before, afford another unlimited field for the best engineering efforts. The Yellow River, for instance, presents problems of engineering equalled only by those of the Mississippi. Something must be done by the Chinese government to change or improve the channel of that mighty stream. Under present conditions, millions of lives are endangered every year by its uprisings and floods. It will take vast sums of money and years of labor to restrain it or direct it within

limits which will protect both people and land from its awful ravages. The Yangtze River, which is one of the most important in all the world, is not so dangerous in its floods, but needs improvement in its channels and course. The same work is needed, on a lesser scale, in the West River, on which Canton is located, and the Pei-ho, on which Tien Tsin is situated. Then there are the bars at the mouths of all these rivers, which should be dredged in order to permit of the free movement of ocean-going steamers. The demands of commerce and trade will make these improvements imperative, even if the government of China is slow to meet the responsibility.

Numerous canals, particularly the Grand Canal, which reaches for 800 miles from the Yangtze to the Pei-ho, should be dredged and opened to the great inland traffic which would surely follow if the mud and filth of centuries were removed from its channel. Lesser canals emptying into it, or located in other sections, require the same class of improvements. As the people of China are especially adapted by habit and taste and experience to life and work on boats, interior traffic on canals will always pay for the money invested to dredge or improve them, provided the government allows them to pass under private control.

Large sections of China would be benefited and made prosperous by the introduction of systems of irrigation modeled upon the same lines as those which have proved successful in America. It may require American engineers to prove this fact to the Chinese, but those who have travelled through the interior of China have seen the great possibilities in this line.

Now a few words regarding the Philippines. After travelling carefully through Nippon, the principal island of Japan, going into the interior and noting present conditions, resources, and possibilities, from the Straits of Sugaru on the north to the Straits of Simonoseki on the south, on the one hand; and after travelling through Luzon, the principal island of the Philippines, from Aparri on the far north to the Straits of San Bernardino on the south, noting carefully in times of peace some years ago the actual resources and apparent possibilities of the island, on the other hand—I can say that, except in the matter of area and population, the comparison is all in favor of Luzon. What I state in this particular as to the resources and undeveloped wealth of the Philippines is supported by every European engineer who has travelled through the islands. Adverse criticisms of the engineering and commercial possibilities of the Philippines come almost entirely from those who draw their conclusions from theory and who

have never been to the Philippines, or at least not beyond the confines of Manila, Ilo Ilo, Cebu, and Zamboanga. When I made my first journey there, I not only travelled through Luzon, but through the Visayan, or central, group, and visited also Mindanao and the Sulu Sultanate. That was before war was even expected between the United States and Spain, and I had no reason to seek a favorable impression, but I then made reports and wrote articles speaking of the Philippines as affording one of the greatest undeveloped material opportunities in all the world, and wondering that Spain had been able to keep them so long in darkness.

At the present time there are only 135 miles of railway constructed in the Philippines. From the letters and reports of competent English, German, and Spanish engineers, there could be built 1,000 to 1,500 miles of railways in the islands during the next fifteen or twenty years, which should pay a good return on the investment. Possibly a conservative estimate, including accessories, would be $50,000,000. By careless mistake in copying, these figures were placed at $150,000,000 in some former published statements of mine. I take this opportunity to correct them in a magazine which must be read largely by experts. With such railway construction will come other kinds of development, which will call not only for engineering skill, but for the investment of more capital, and which will provide wider markets for exports. When there is added to these railway possibilities, the needed improvement of rivers and harbors, and the development along modern lines of the great Philippine industries of hemp, tobacco, sugar, copra, rice, spices, together with the latent resources of coal, iron, gold, tin, copper, and other minerals and metals which are proved to exist in paying quantities, we have a realization of the material side of the Philippine problem.

A word in passing about Siam may call the attention of engineers and capitalists to a country which is deserving of their consideration. Next to Japan, there is no other country of Asia or no portion of Asia that is making more advancement. With an area of 250,000 square miles, a population of 10,000,000, and a foreign trade of $25,000,000, it is entering upon a period of progress and prosperity unprecedented in its history or in that of any Asiatic land aside from Japan. Led by a king, who in some respects is the ablest statesman in Asia, and advised by picked men taken from the councils of European governments, it is making a strong effort for recognition throughout the world as a country of importance and influence in both commerce and politics. It has great staple products to sell, and it has a large buying

capacity. It needs extended railway construction throughout the interior, the improvement of its waterways, rivers, and canals, all of which are being planned by the present government. Bangkok, the capital city, with a population of half a million, has already electric lights, electric street-car lines, telephones, and telegraphs; but it wants a system of sanitation and of waterworks.

It has been my purpose in this article to show the greatness of the Chinese or Asiatic field of commerce and exploitation in order to prove more conclusively the necessity of America, England, and Germany working together for the permanent maintainance of the open door. If China was not worth such attention upon the part of these three great powers, there would be no reason for supporting such a policy. The greater portion of this article could, therefore, be considered as devoted to the premises from which the conclusions are drawn. It should be demonstrated by what has been said, that there is in China a field which is worthy of the best efforts in friendly competition of England, Germany, and America to control or share. There is no valid reason why the manufacturers and exporters of these countries, each recognizing the strength of the others, should not unite in urging their respective governments to protect the great markets into which they are entering with so much earnestness, and to which they look with such hopes for the future. Each country is confident of its power to compete with the others where there is a fair field and no favor. Therefore, there is every reason why they should unite to prevent a divided field and open discrimination. There is abundant room for all. Wherever these three great powers, the chief industrial nations of the world, will unite to maintain the open door, or freedom of trade, with equal privileges to all, there will be found an ideal condition which will suit the producers of all three nations.

There is need of immediate action in Peking. In another six months or a year, it may be too late. The tendency is all towards "spheres of influence," which are no less than sugar-coated diplomatic terms for "areas of eventual actual sovereignty." Unfortunately, Germany and England are, in a measure, committed to the principle of spheres of influence. Germany, by her occupation of Kaichau and the extension of preferential concessions through Shantung, and England, by her position in the Yangtze Valley and her recent agreement with Russia, have taken a position which is hardly consistent with freedom of trade and rights to all countries. America, therefore, stands to-day as the one great power which has not yielded to

the temptation of the hour and acknowledged, by formal or informal act, the right of any power to a sphere of influence. She is, in other words, the arbiter of China's future. Were she to take the steps already taken by every other important nation, China would go to pieces like an arch from which the keystone had been withdrawn. If now the United States is strong enough in influence and example to hold Germany, Great Britain, and Japan with her in her avowed policy of maintaining the integrity of the Empire and the spirit and letter of the Tien Tsin treaties, she will not only have accomplished for herself the greatest good, but immeasurable benefits for the other powers concerned. This is a position of splendid leadership which the government and people of the United States should appreciate. It should inspire the President to strong, careful action, and the people to support him in what he undertakes.

This leads to my final conclusions. The United States, supported by England, Germany, and possibly by Japan, should stand for the absolute integrity of the present Chinese Empire as known and understood in the treatics; second, for the unrestricted privileges of trade and commerce guaranteed by these same treaties; third, reforms in the government of China which shall not only enable her to govern herself successfully, but protect the interests of foreigners and foreign nations throughout her limits; but, fourth—in the event that the break-up of China seems inevitable, and neither the United States nor any other government stands ready to prevent the division—for the maintainance of the open door in the various spheres of influence, or the same privileges of trade throughout China divided that existed when she was intact.

We must be practical in looking at the situation. The United States cannot afford to stand blindly for the preservation of China as an independent empire, unless they are willing to go to war. It is plain that the American people would not support such a policy as that. Therefore, they must exercise, in connection with other nations, their moral influence to the last degree.

The chief danger is often described as coming from Russia. And Manchuria is now considered essentially Russian. Russia cannot be blamed if she endeavors to build up a market within her own domain for her own manufactories, but other countries, if they would properly guard their respective interests, must see that those markets are kept open to them, without favor or discrimination, which are guaranteed by the old Chinese treaties.

If America, England and Germany will exert in unison the influ-

ence which each individually possesses, there will be no question as to the success of their policy. Once seeing that these three powers are in earnest, Russia and France will be compelled to join them without thought or suggestion of war.

Would that some strong guiding hand could direct the relations of these three powers so that they would take the necessary steps before it is too late! What ozone would be breathed into the political atmosphere of Peking if it was definitely announced that America, England, and Germany, followed by Japan, were determined to maintain the integrity of the empire and the spirit and letter of the Tien Tsin treaties throughout all China, from the old boundary lines in the south to those in the north, without reference to alleged spheres of influence, and that China herself must reciprocate their interest in her welfare by instituting the reforms in her government which are so needed and pressing! Hardly would the announcement go up and down Legation Street before Russia and France would see the futility of opposition and echo the sentiment with the same strong force with which it was first announced. Peking politics are in as bad a state as her awful streets, with their mud holes and deceptive hollows. The conditions are as jarring to justice and right as the jolting of her famous carts is to the nerves of the occupant.

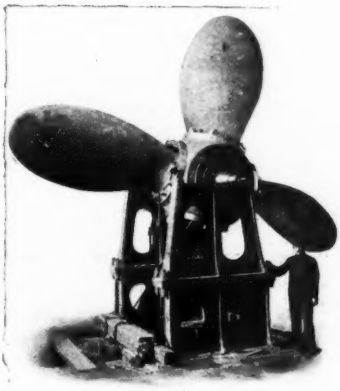
If now America, England, and Germany will come forward and rescue not only China, but their own interests, from the impending disaster, they will perform a duty, not only to the millions of China and to themselves, but to all the world. If they will stand as allies for the open door, the door will never be closed. The future of China as a nation, as a market for their products and a field for their legitimate exploitation, depends upon their united efforts.

It is possible that America alone, were she ready to meet the responsibility, could determine the future of China, preserve the Empire from division, enjoy permanently the privileges of the Tien Tsin treaties, and compel the inauguration of reforms; but political conditions in the United States would never support the government in shouldering this responsibility. On the other hand, if the people of the United States are convinced that by joining forces with England, Germany, and all other powers having like interests, their field of commercial expansion can be protected and enlarged, without war but with the simple exercise of moral pressure, they will support the government in such a policy.

THE DEVELOPMENT OF GERMAN SHIP-BUILDING.

By Rudolph Haack.

III.—THE SHIP YARDS ON THE BALTIC.



THE last article enumerated all the yards on the North-Sea coast, and we now begin in the Baltic with the yard of the Flensburger Schiffbau Company, in the harbor of Flensburg on the north coast of Schleswig. This yard and the machine shops are new, started by citizens of Flensburg in 1872, and from the very start always increasingly active. Mr. Bredsdorff is manager of the ship-building department, and Mr. Bauer manager of the machine shops. The chief business of the firm is to build passenger steamers and freighters, especially large sea-going steamers of 4,000 to 8,000 tons; but it builds vessels also for the Baltic and North-Sea trade, especially for the lumber trade, and also large sailing vessels as well as smaller vessels of all kinds. The fact that in 1890 the output was 14,196 gross tons with 6,915 i.h.p., and in 1897, 29,357 gross tons with 12,620 i.h.p. shows the tremendous forward spurt of this firm in recent years. It has constantly earned good profits—a sure indication of favourable situation and intelligent management. This is also proved by the yearly turnover, which last year amounted to 7,000,000 Mk., and by the dividends which have been 8 per cent. to 10 per cent., and in the year 1890-91 reached 18 per cent.

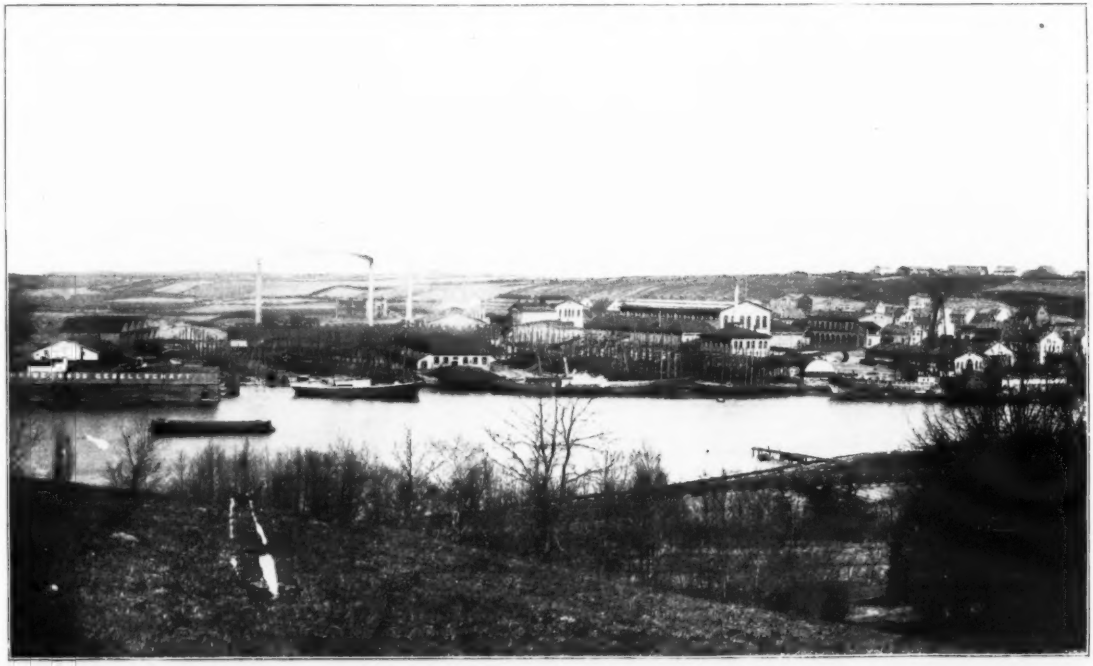
A steady supply of work of one kind does not require relatively so large a number of engineers, officials, and foremen as are needed in yards whose business is more diversified. In the Flensburg yard there are only eight naval constructors, seven mechanical engineers, and thirty-eight officials and foremen. The increase in the number of workmen on the pay roll is as follows: In the ship-building depart-

ment, in the fiscal year 1890-91 seven hundred and twenty-nine, but in 1897-98, one thousand three hundred and ninety-seven. In the machine shops, three hundred and fifty in 1890-91 and four hundred and seventy-three in 1897-98—from which figures the advance in importance can be judged.

War vessels have not been built at Flensburg; but on foreign orders twenty-two merchant ships, with a total gross tonnage of 25,320 and 12,110 i.h.p. and, for the same trade, three self-trimming dumping barges and one steamer of 5,900 gross tons and 2,500 i.h.p. are now on the ways. In addition to the above-mentioned kinds of ships, the firm also executed such cognate orders as floating cranes, ice-breakers, floating docks and, as a specialty, the Clark and Stanfield off-shore docks, of which the firm owns one at its own yard, using it for repair work.

The active enterprise of the firm is further shown by the fact that a recent purchase has been made adding 27 acres to the existing 11 acres area of the yards, and by this addition it can realise plans already formed for a very material increase in the size of the establishment. Among all the many ship-yards of Germany, there is scarcely one to be found which surpasses the Flensburg yards in steady, conservative, yet rapid development and increase.

The North German ship-yards of Kiel had been active for many years and had completed a number of war and merchant vessels when, in 1879, it was taken over by the ship and engine-building joint-stock company "Germania," which also and at the same time took over the going engine works of F. A. Egells, which had been started in Berlin in 1825. When work on the Prussian navy was first begun this firm supplied many engines for the wooden gunboats already mentioned, and as orders increased for large engines for the navy, the whole establishment, which had become a joint-stock company, was moved from Chaussee Street, Berlin, to Tegel near Berlin, where great work-shops for engines and boilers were planned and built. Here many of the engines were made for these vessels, built partly before 1879 in the North German ship-yards and later in the yards of the new company. It was found, however, that the great distance between the two departments, (ship-building yards and engine works) had many disadvantages, especially in winter when ice hindered seriously the carriage of boilers and other heavy pieces. This, as well as insufficiency of working capital, was the chief reason for the company's lack of prosperity, and led the shareholders to consent to the sale of the works to Friederich Krupp of Essen in 1896.



GENERAL VIEW OF THE KIEL SHIP-YARDS IN 1885.

STETTINER LLOYD STEAMER MARTHA.

1,000 i. h. p.; built at the Kiel ship-yards in 1884.

New life was thus infused into the establishment, and this first showed itself by plans for the removal of engine works and machine shops at Kiel. The works at Tegel covered 15 acres, while the new works at Kiel have an area of nearly 22 acres and the area of the ship-yards has been increased from 14 to 34 acres.

Notwithstanding the change of ownership and location, the old managers—Mr. Schulz for engine works and Marine-Oberbaurath Rauchfuss for ship building—have held their positions. The former has under him fifty-three, the latter forty-seven, engineers busy with designs, plans, estimates, and the oversight of the work. In the work-shops and in the yards there are eight overseers and forty-six fore-men, responsible for accurate work, and in the office there are sixty-seven employees. In 1890 there were six hundred and seventy-six workmen on the pay roll in the engine works and in 1898 this num-ber had increased to one thousand one hundred and sixty. In the ship-yards the increase was from nine hundred and ninety-six to one thousand three hundred and one, so that the total number of work-men on pay roll at the beginning of this year was two thousand four hundred and sixty-one.

These yards, since their establishment, have built for the imperial German navy ten battle-ships, among them the ironclad of the first class "Wörth," the protected cruisers "Kaiserin Augusta," and "Prin-cess Wilhelm," as well as the engines for several vessels built in the Imperial navy yards. For foreign sea-powers the firm has built three

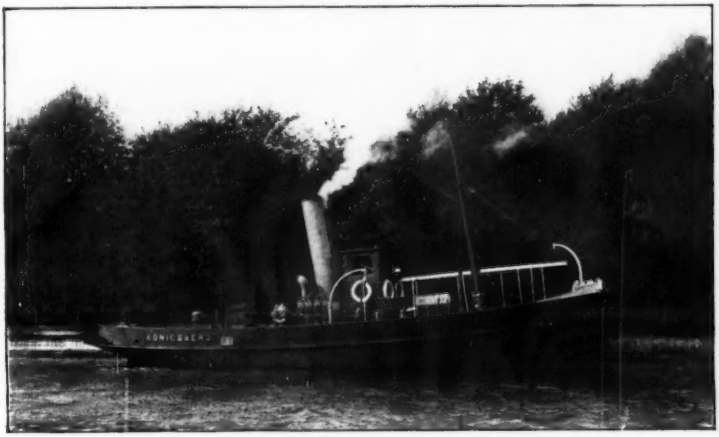
large ships and sixty-five torpedo boats and torpedo-boat destroyers, twenty-seven merchant steamers of various kinds and sizes, and four steamers for the African colonies.

At the beginning of the year there were on the ways one first-class battle-ship, three cruisers, one torpedo-cruiser, three torpedo boats, and one racing yacht.

In addition to ship-building the firm also built steam dredges, dock gates and locks, racing yachts, mining machinery, steam pumps, hydraulic plants, stationary engines, etc.

In 1838 Mr. A. F. Howaldt started, in Kiel, machine shops which were later taken over by the firm "Schweffel and Howaldt," and at a comparatively early date marine engines were built; the sons of the original owners of this concern added (in 1865 at the same place) yards for iron ships, and later, under the firm name of "Howaldtswerke," the whole establisment was entirely rebuilt on yards of 9 acres extent at Dietrichsdorf at Kiel, engine works being added.

The yards are under the management of the brothers Howaldt and have rapidly increased, being principally busy with freighters and passenger steamers of all kinds, among them, and the largest, a vessel 390 ft. long, 55 ft. beam, and 25 ft. 9 in. hold. The firm builds also sailing vessels, dredges, boilers, railway supplies, steel and bronze castings, and forgings of large size.



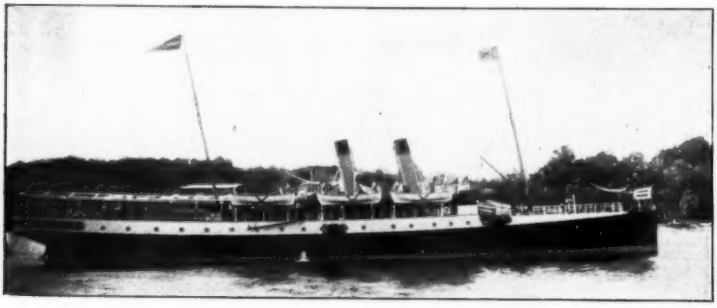
TOWING AND WRECKING STEAMER KÖNIGSBERG.

42.89 tons, 100 i. h. p. Capacity of wrecking pumps, 4,750 gals. per minute. Built by Howaldtswerke, Kiel, in 1896, for the Imperial canals.

The following figures are proof of rapid advance in comparatively a short time: Ships delivered in 1890 gross tons, 10,331, with 5,227 i.h.p.; in 1898, 16,375, with 9,115 i.h.p. The total turnover in the working year 1897-8 was 5,700,000 Mk. In the offices and shops are ten naval constructors, eighteen mechanical engineers, and sixty-two officials and foremen. In 1890, the average of workmen employed was one thousand four hundred and sixty-nine and in 1898 this had increased to two thousand three hundred and twenty-seven. Two floating docks, each of 3,200 tons lifting capacity, and a third, now building, of 3,500 tons, are used for repairs, for which (owing to the constant increase of shipping through the North-Sea-Baltic canal), there is always large demand. The management have also made special and persistent efforts to secure foreign orders. They have sold ships to Russian, Swedish, French, Danish, Roumanian and Honduras customers, and their enterprise and activity will cause the Howaldtswerke to grow still further.

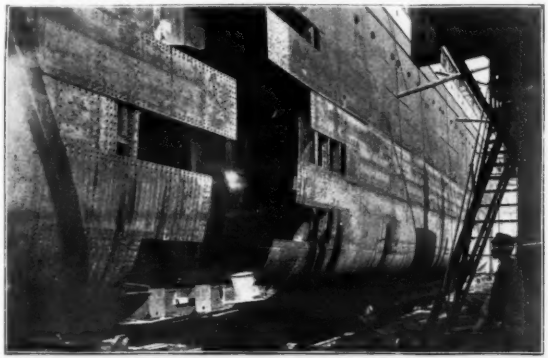
There are still two very small yards for wooden ships in the bay of Kiel, that of Scharstein in Dietrichsdorf and the other of G. Krüger, in Seedorf. The former builds pleasure yachts, the latter small sail-boats.

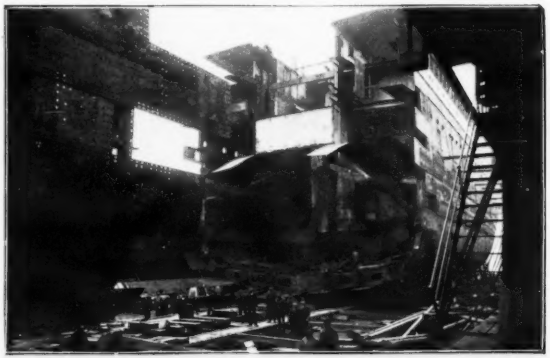
The next big establishment for large iron vessels, that of the firm Henry Koch in Lübeck, whose title mentions its location, was founded in 1882-83 and is still carried on by the heirs of the founder —the brothers Koch. The work done in 1897 had a value of 2,500,000 Mk.; the vessels registered 32,451 gross tons and their engines were of 1,250 i.h.p. At the beginning of the year eight vessels of

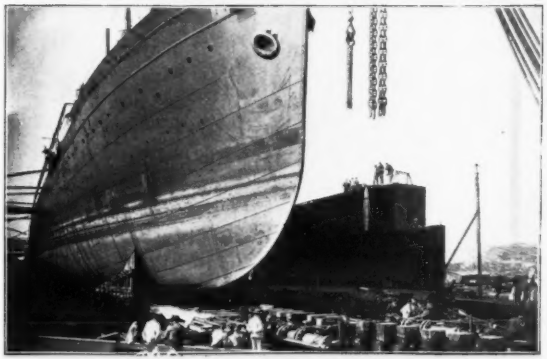


IMPERIAL GERMAN MAIL STEAMER PRINZ ADALBERT.

253 tons net. Two triple-expansion engines of 1,250 i. h. p. total Speed, 15 knots. Built at Howaldtswerke, Kiel.







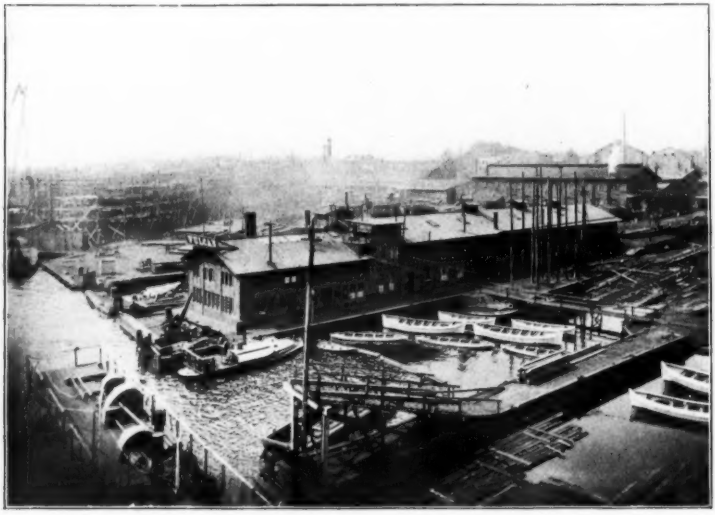
View at 6 meters extension.
The bow, showing the ways and hydraulic motors.

View at completion, 20 meters extension.
View at the start. The rivets cut away.

FOUR STAGES IN THE LENGTHENING OF THE SPREE—NOW THE KAISERIN MARIA THERESIA—AT THE VULCAN WORKS, STETTIN.

9,350 gross registry and 3,350 i.h.p. were on the ways. Eight engineers, twenty-five foremen and officials, and five hundred to five hundred and twenty workmen are actually employed. The area of the yards is nearly 10 acres and in front of the yards are two floating docks for repair work; owing to the growth of shipping at Lübeck these are often in use. For a long time this firm was short of orders, but more recently has been fully employed with profitable contracts, and this speaks well for growing confidence and satisfactory results.

One of the oldest of the German yards for iron vessels is the Aktien-Gesellschaft "Neptun" in Rostock. This was started in the



THE VULCAN WORKS, STETTIN. PANORAMA COMPLETED ON OPPOSITE PAGE.

fifties by the engineer Tischbein, and from the start iron steamers were built of a tonnage then considered large, but no profit was made owing to the lack both of experience and of competent workmen. There was no improvement when the establishment was taken over by a joint-stock company and its area increased by the purchase of adjacent land, nor until finally, after many changes of management, the whole concern was taken over by the present joint-stock company "Neptun."

In 1890 the yards turned out a total gross tonnage of only 9,000, with 2,300 i.h.p.; but in 1897 this had grown to 18,600 gross tons with

5,300 i.h.p., with a turnover of 2,960,000 Mk. Seven hundred and sixty workmen were employed in 1890 and this number increased gradually to eleven hundred in 1898. The directors, Barg and Knappe, manage the whole business and have on their staff five naval constructors, twelve mechanical engineers, twelve commercial employees and eighteen foremen. The yards were almost entirely reconstructed in 1894, provided with good modern machines and apparatus, and the whole plant now covers an area of 22 acres.

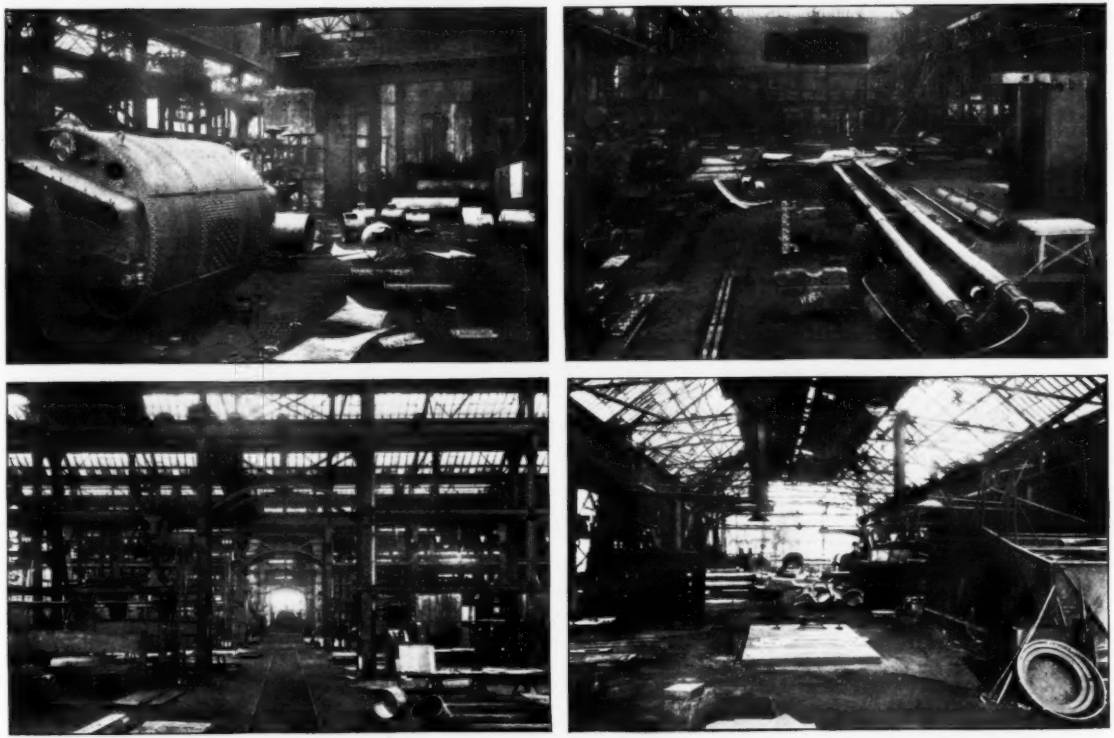
In addition to ships for German registry the "Neptun" built merchant steamers for Sweden and Russia and, as its appliances are

THE VULCAN WORKS, STETTIN. COMPLETING THE VIEW SHOWN ON PAGE 18.

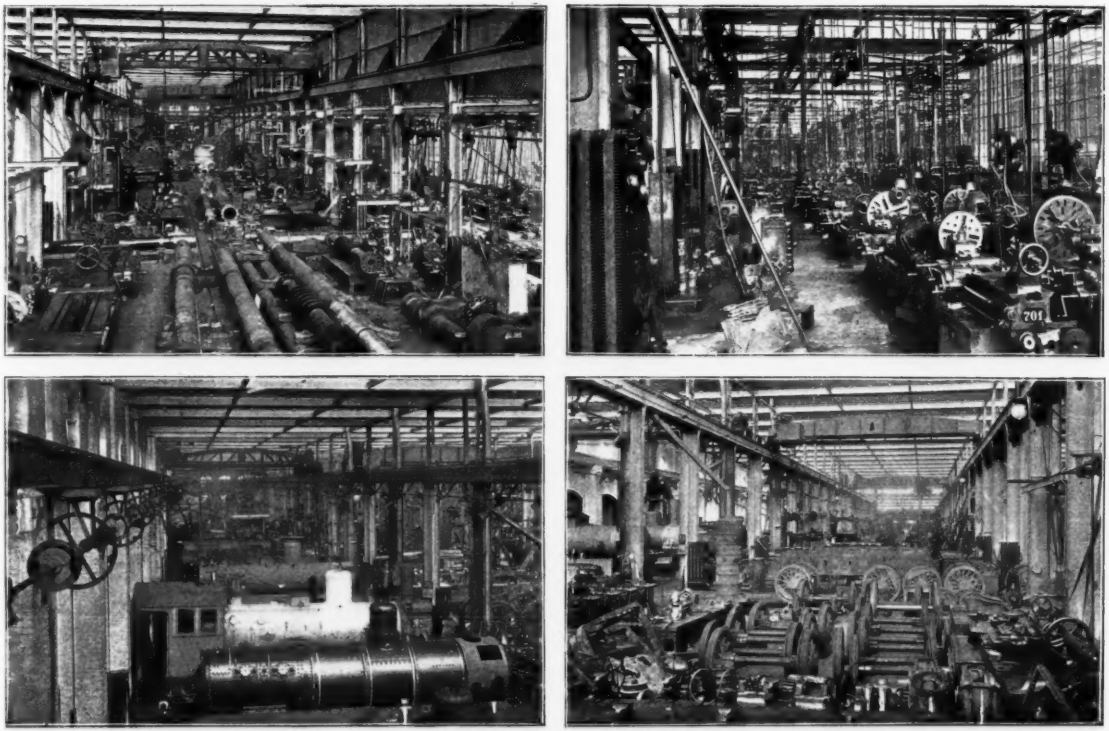
large enough for vessels even of 10,000 tons and wages are comparatively low, it will have plenty to do under normal conditions. For repair work the very insignificant shipping interests of Rostock are not very favourable. Larger vessels occasionally come from other harbours, and for such repair work there is a marine railway and special workshops.

From Rostock to Stettin there are a few scattered and small yards —as at Barth, Stralsund, etc.—building wooden ships.

We now come to the largest and most important private shipyard in Germany, which also has played the most important part in



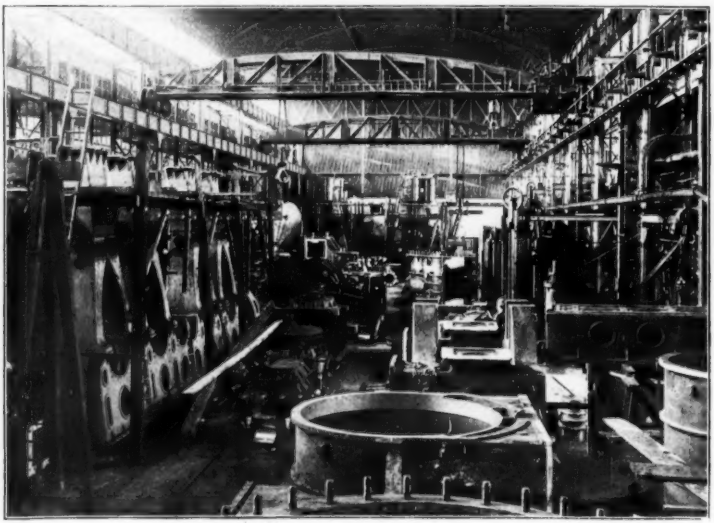
GLIMPSES OF THE VULCAN BOILER SHOPS, AT STETTIN.



FOUR BAYS IN THE LOCOMOTIVE AND LATHE SHOPS AT STETTIN.

the development of German ship-building. It is the Stettiner Maschinenbau-Aktien-Gesellschaft "Vulcan" in Bredow-Stettin. Two engineers, born in Hamburg, but trained at Berlin in the engine works of Wöhlert (which have long since gone out of existence) founded in 1851, under the firm name of "Früchtenicht und Brock," a little yard and machine shop at Bredow, in which they planned to make machines of all kinds. In the yard they began the construction of a little side-wheel passenger steamer "Die Dievenow," which began in 1852 to make trips on the lower Oder, and was so well built that she is still running. As early as 1855 the contract was taken to build for a Stettin firm three sister screw steamers, of dimensions at that early date considered large; but the shops were not equal to the task. They had neither engineers, designers, workmen, nor tools, nor were they provided with the necessary capital to increase their plant, which was therefore taken over by the present joint-stock company.

But for a long time this new concern met with no success. There



PART OF THE VULCAN ERECTING SHOP.

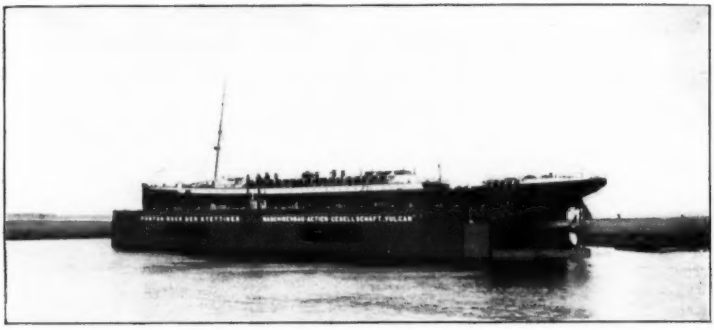
were no orders, and therefore lack of steady work; nor did engine building prove profitable, although, to increase it, tools were secured for the building of locomotives for which, however, at that time there was very little demand. But the beginnings of German railroad

development at about that date soon stimulated a demand for locomotives, and this exceeded in value the demand for ships, and, as skill was acquired, some money was made and the profit from this source more than once was of exceeding use in tiding over financial difficul-

LATHE SHOP, VULCAN WORKS.

ties. But ship-building lagged, notwithstanding improvement in design and construction. Contracts were only secured on small margins until, after the successful ending of the war of 1871, a contract was accepted to build the iron-clad frigate "Preussen," against the advice of those most competent and even against the advice of the chief constructor of the Imperial navy. Instantly everything changed favourably and ship-building began to be more and more profitable, especially as big orders poured in for men-of-war for Germany, and for China and other foreign sea powers.

As the years rolled by there was once more trouble, and this was when the delivery of the six Imperial mail steamers in 1887 did not seem *a priori* to promise any very satisfactory result. It became manifest, however, not only that these steamers had caused no



THE KAISERIN MARIA THERESIA IN FLOATING DRY DOCK AT STETTIN.

trouble, but that their excellent construction had proved that the "Vulcan" was quite as competent to contract for ships of this kind as any British yard, and it thus earned for itself in particular, and for German ship-building in general, the confidence of the strongest shipping firms. It soon secured the contract for the first fast passenger steamers of the Hamburg company and the North German Lloyd, and these were followed by other contracts, so that the company was soon able to pay good dividends to its shareholders, although in this direction the building of locomotives had brought about considerable improvement at an earlier date.

Up to the present time, the "Vulcan" works have built, including the ships still on the ways, sixty-one large and small war vessels and one hundred and thirty-seven large screw steamers for the merchant service and forty-nine side-wheel steamers of various types.

With this great increase in the activity of the plant in its several branches it has been necessary several times to rebuild shops and renew equipment, and at the present time it has attained a high degree of perfection in its many departments. The various illustrations give a better idea than written description. It may, however, be mentioned that the plant at present covers an area of more than 61 acres.

The increase in ship-building activity is best indicated by figures:

1851	Ships	102	Gross reg. tons.	Engines	200 i.h.p.
*1857	Ships	2,648	Gross reg. tons.	Engines	3,820 i.h.p.
1890	Ships	14,207	Gross reg. tons.	Engines	25,600 i.h.p.
1896	Ships	20,390	Displacement.	Engines	44,000 i.h.p.
1898	Ships	71,600	Gross reg. tons.	Engines	174,000 i.h.p.

* This was the year of incorporation as a joint-stock company.

This includes ships still on the ways at the beginning of 1899. The turnover in 1897 was, in round numbers 20,000,000 Mk.

In this tonnage eleven large war ships are included, of which two are not yet finished, amounting in all to a displacement of 50,000 tons and about 90,000 i.h.p.; twenty-three torpedo boats with 1,400 tons displacement and 17,000 i.h.p., and twenty-seven large and small merchant steamers of 15,000 tons displacement and about 16,500 i.h.p., which were ordered by foreign governments and firms.

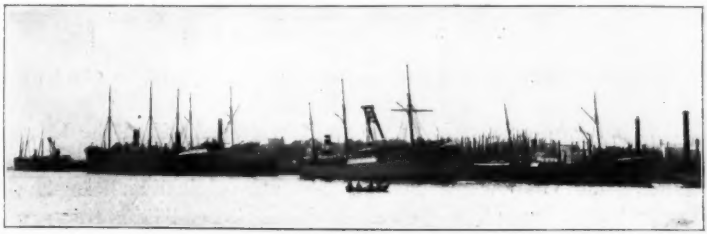
The locomotive department turns out about one hundred locomotives annually.

The present managers are Messrs. Stahl, Zimmerman and Flohr, assisted by a staff of seventy-four naval constructors, seventy-eight mechanical engineeers, one hundred and seven office staff and other officials, and one hundred and seven foremen.

In the year 1890 four thousand seven hundred and seventy workmen were employed, and in 1897, five thousand seven hundred.

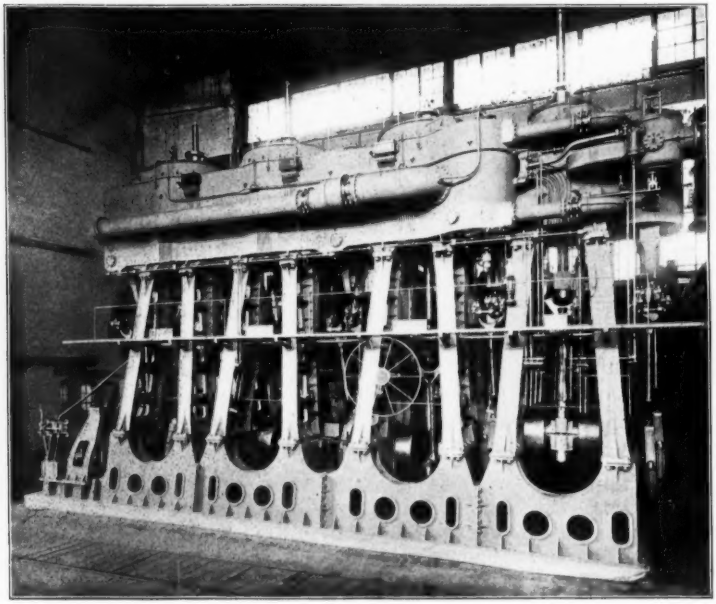
Everything connected with the building or repair of ships and vessels of every kind—dredges, floating cranes, and all similar work—is undertaken by the "Vulcan" and completed almost wholly in its own plant. As part of the equipment there are two floating docks of iron, the largest with a lifting capacity of 12,000 tons. The largest vessel now building, or ever built in Germany, is the already mentioned Deutschland for the Hamburg-American Company. Its dimensions are 662 ft. 9 in. between perpendiculars; its greatest beam 67 ft., and it is equipped with two quadruple expansion engines, each of 16,500 i.h.p., a total of 33,000 I.H.P. The dimensions of each engine are:

2 High-pressure cylinders.....	36.6 in. (930 mm.)	diameter.
1st Intermediate cylinder.....	73.6 in. (1,870 mm.)	diameter.
2nd Intermediate cylinder.....	104.0 in. (2,640 mm.)	diameter.
2 Low-pressure cylinders.....	106.2 in. (2,700 mm.)	diameter.
Piston stroke	73.0 in. (1,850 mm.)	



SHIPPING AT THE ODERWERKE, STETTIN.

The size and capacity of the "Vulcan" place it at the head of all German ship-building plants and make it equal to the largest of other countries' plants. In its offices and shops the final touches have been given to the training of a great number of engineers and many of them are to-day managers of other works. In addition, many workmen have learned their trade in the "Vulcan" works, and are either still working there or have found good paying jobs in the Imperial and private yards. Also the well-known extraordinary performances of the "Kaiser Wilhelm," built in the "Vulcan" yards, have given to

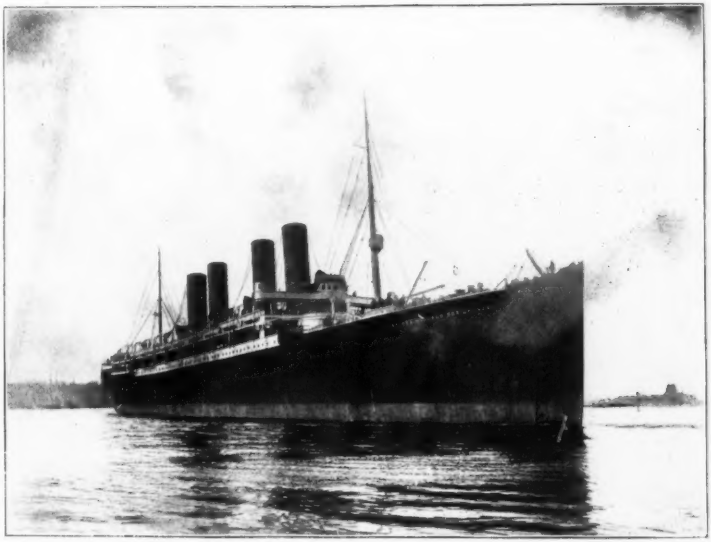


FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE KAISER WILHELM DER GROSSE.
27,000 i. h. p. Schlick counterbalancing system.

German ship-building a name and fame which has spread far and wide and is unsurpassed by that of any other land.

Another yard in Stettin has recently worked itself to the front. It is the Aktien-Gesellschaft "Oderwerke," Maschinenfabrik und Schiffswerft, of Grabow near Stettin. This was originally a little plant founded under the name "Stettiner Eisengiesserei" in 1837; it gradually grew and was finally taken in hand by Messrs. Möller and

Holberg. These soon added ship-building to the other work, bought out other neighboring plants and yards, and sold the whole again to a joint-stock company whose success was not what the shareholders expected. The whole plant, therefore, passed by sale to the above-named company, which increased its capacity and facilities by new buildings, tools, shops, floating docks, etc., and it continued to manu-



THE KAISER WILHELM DER GROSSE LEAVING SWINEMÜNDE, SEPTEMBER 14, 1897.

facture in a number of other lines besides ship-building, which therefore developed but slowly.

In 1889-90 steamers were built engined with 3,635 i.h.p.; by 1897-98 the engine output increased to 5,000 i.h.p., and last year the cash turnover was 3,330,000 Mk.

The present managers are Messrs. Annell, Blackstady, Heumann and Fink; the staff includes ten naval constructors and twenty-three mechanical engineers, as well as eighty other employees; the number of workmen varied, between 1889 and 1898, from one thousand to one thousand nine hundred and the yard covers an area of 34½ acres.

In addition to ship-building, the company builds stationary engines, sugar machinery, brick-making machinery, and undertakes re-

pairs of every kind for these specialties as well as for other machinery and ships. Up to the present the company has sold abroad twenty-three merchant steamers, of a total of 9,075 gross tons burden with engines of 7,105 i.h.p. The largest steamers as yet built do not exceed 1,300 tons burden; the largest iron sailing vessels are of 2,400 tons and the largest engines are of 1,100 i.h.p. The equipment and area of the yards ought to permit a large increase in these sizes.

This company has made its greatest progress in the last few years, so that further favourable growth and increased earnings are to be expected.

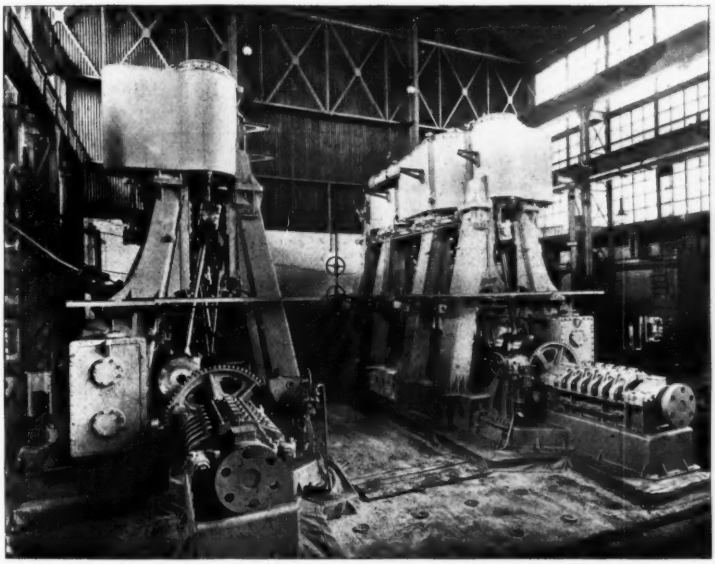
In 1890, at Grabow near Stettin, Messrs. Joh. Nüscke and O. C. Peuss established a yard for the building of iron passenger steamers and freighters. This yard had built wooden ships as early as 1815, and then fallen to the condition of a repair yard; but now, since the above firm have taken hold, it has advanced from a delivery of iron ships of a total of 250 gross tons register and 250 i.h.p. in the first year, to 3,490 gross tons in 1897-98, with 1,940 i.h.p., and a yearly turnover of 1,000,000 Mk., in which are included very numerous and important repairs.

Under the management of the owners are seven engineers and three hundred and twenty workmen, although the latter only numbered seventy-five in 1890.

The yards and plant cover an area of nearly 3 acres, and the little engine works build not only marine engines, but also engines for farm use and for drying purposes. Ships needing repairs are placed either in the floating dry-dock or drawn out of the water on the moving ways. Last year Stettin was made a great free port and the consequent increase of shipping interests at Stettin promises for these yards growth and prosperity.

In addition to the Imperial navy yards, there are four private yards in Danzig in which vessels of iron and steel are built. The first of these dates back in its beginning to the last century, and is that of I. W. Klawitter in Danzig, of which place the oldest ship-builder of this name was a native in the year 1589. Great activity was developed here in the building of wooden ships, and many sailing vessels of all kinds were built before 1877. In 1855 the first corvette of the Prussian navy was also built here, the engines coming from England. This was followed by orders for a number of wooden gun-boats, with German engines, and the owners also began as early as 1853 to build iron cargo boats of about 500 tons burden, with engines of 250 i.h.p.

From 1875 on the works were completely re-equipped for the



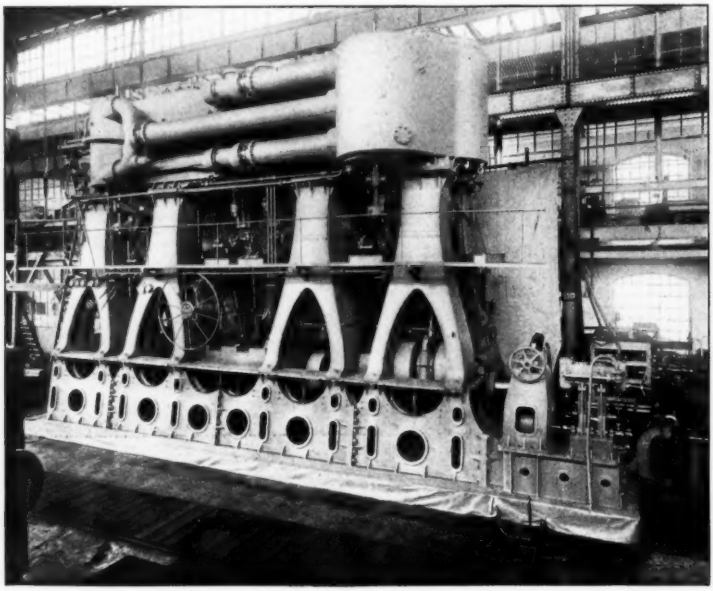
FOUR-CYLINDER QUADRUPLE-EXPANSION ENGINES OF 5,000 I. H. P.
Built at Stettin in 1898-99 for the Hamburg-American steamer Patricia.

building of iron and steel vessels, and engine works and boiler shop added to the plant. Up to 1897, the firm delivered thirty-six boats such as steam dredges, barges, barrack and fire boats, etc.

Conditions of navigation on the Vistula make it essential that there shall be great power and very little draft in the boats going up and down this river, and the firm was very successful in solving this problem, so that they received a number of orders for boats of similar design. In addition, the firm sent out freighters up to 200 tons with engines of 1,500 i.h.p.

The firm owns an old wooden floating dock, dating from 1850, in which the very first Prussian war vessels were docked before there were any better government facilities, and this is now used to take vessels out of the water for repairs. Besides this antiquated dock, the yard is equipped with two marine railways of best modern design. The area of the yards is about 9 acres and under the management of Mr. Klawitter there is a staff of fifteen engineers, thirty foremen and salaried employees, and on the pay roll about seven hundred workmen.

A second concern, started quite early, in the old sea port of Danzig, is the firm of Danziger Schiffswerft und Maschinenbauanstalt Johannsen and Co., which was founded in 1856 by F. Behrends and Devrient and until 1869 was occupied only with the building of wood-



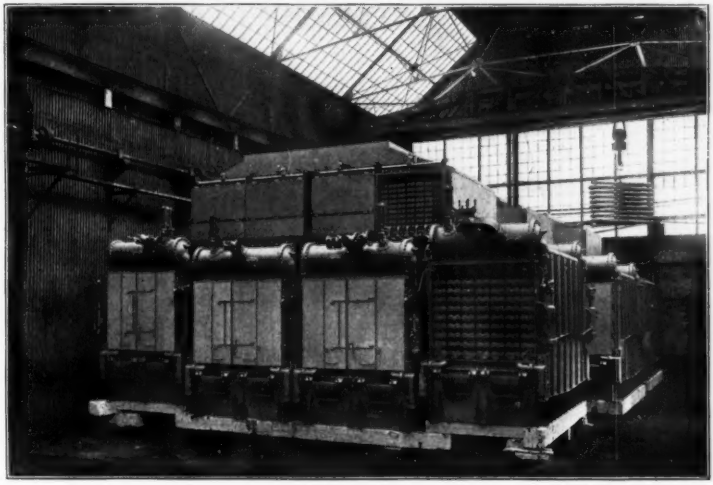
FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE KAISERIN MARIA THERESIA.
16 000 i. h. p. Schlick counterbalancing system. Built at the Vulcan works, 1898-99.

en sailing vessels. At this date the building of iron ships was begun, but nothing of importance done until, in 1890, the old firm was taken over by the new concern above named. The business is now carried on with a staff of five officials and one hundred and twenty workmen; it delivered, in 1897, 600 registered tons, of which one ship was of 200 ft. length and about 670 i.h.p., and it executed some foreign orders in addition. It builds also dredges and barges, and undertakes repairs for all kinds of shipping, for which purpose there is a marine railway. The whole plant covers an area of about 3½ acres.

A larger yard than this one, owned by the firm H. Merten, Ges. m. b. Haftung, was also located at Danzig in 1878; it builds iron freighters, passenger steamers, and steam tug-boats up to a length

of 200 ft. Larger engines are purchased from other firms, the machine shop only building sizes up to 48 i.h.p. At present there is a staff of twelve engineers, who direct three hundred and sixteen workmen; and in 1898 eighteen little vessels of a total tonnage of 948 gross tons were built. The area of these yards is nearly 5 acres.

By far the largest yards in Danzig are those of the firm F. Schichau, and they are indeed among the largest in all Germany and were established in 1891 by the Maschinenfabrik und Schiffswerft F. Schichau, in Elbing, for the building of big vessels, for which water depth and other conditions were not favourable on the Elbing river. The eminent Kommerzienrath F. Schichau, who died a few years ago, was the founder of these works and German industry owes him a great debt of gratitude. He started in 1837 with a little plant in Elbing for general machine work and engine building, and soon took up little boats, dredges, etc. As early as 1855 a screw steamer was built, which for many years plied on the Baltic. Towards the end of the seventies



BELLEVILLE WATER-TUBE BOILERS FOR JAPANESE CRUISER YAKUMO.

43,400 sq. ft. heating surface and 1,210 sq. ft. grate surface. Built at the Vulcan works

he began to build torpedo-boats for Russia, and later, when the German navy wanted these in great number, owing to his experience those built by Schichau were for a long time preferred to others. Very recently a few other firms—the Germania in Kiel for instance—have

received torpedo-boat orders, but the greatest number still come from Elbing. It was also quite in order that many foreign powers should make use of the very great experience of these Schichau yards in this particular, and therefore orders in great number were received for torpedo-boats and torpedo-boat destroyers, and so the deliveries for both yards, at Danzig and Elbing, amounted last year to 667, nearly all of them torpedo-boats. It is only since the equipment of the yards in Danzig that orders have been taken for the largest vessels, and among them battle ships for the German and Russian navies, great passenger steamers and freighters for the North German Lloyd of Bremen, etc.

The machine shops at Elbing not only delivered the torpedo-boats, etc., but also all the engines for all vessels built there and has besides built, since its organisation, about one thousand locomotives and many stationary engines; its fame extends far beyond German borders.

Further east towards Königsberg, where formerly wooden-ship building flourished, there is still a yard dating from that time—that of Gustav Fechter—which undertakes to build little iron ships, but is now doing very little.

The firm Memler Maschinen und Schiffbau Giesserei und Kesselschmiede, Kroll & Eulert, in Memel, is doing some work under conditions somewhat more favourable. It builds little cargo boats and passenger steamers of every kind, of which in 1898 it delivered 370 gross tons. In 1897 the turn over was 200,000 Mk., employment being given to two engineers and from one hundred and forty to two hundred workmen in yards with an area of 3 acres.

STANDARDISING IN ENGINEERING CONSTRUCTION.

By Sir Benjamin C. Browne.

I.—ECONOMY OF TIME, LABOUR, AND EXPENSE IN WORKING TO STANDARD TYPES.

A CONSIDERABLE amount of attention has been lately drawn to the number of orders for engineering plant and material which have gone from Great Britain to the United States, and it would appear that both our manufacturers and the public generally are seriously concerned at the large volume of work that has left the country. Many reasons have been brought forward to explain the case, and to show wherein the Americans have advantages over us. Some of these may be due to natural causes, but some are probably due to their better system, or greater business aptitude.

One point on which I now wish to dwell is the fact that they apparently work, much more thoroughly than we do, to standard types and specialties. It is, of course, a question which admits of no absolute solution how far it is better to use what may be called "ready-made" articles, and how far to have articles specially made for the purpose; but, in the case of some of the orders that have gone past us, there is a great deal to indicate that if the English worked more to standard patterns they would have secured some, at any rate, of the orders which have now gone across the Atlantic. It is, of course, by no means altogether the fault of the manufacturers, and I shall have a good deal to say as to how far the purchasers, their professional advisers, and the consulting engineers of the country generally are responsible for this state of affairs.

There are three points which I specially wish to look at as illustrations from this point of view. First, that the Egyptian authorities placed with the Americans an order for a bridge, for the Soudanese Railway over the Atbara River, on account of getting very much quicker delivery than they could get in this country. Second, certain railways, especially the Midland and the Great Northern, have given large locomotive orders to America, and thirdly, an ever increasing number of machine tools, especially for engineering work, come from the States. We may also add that the electrical plant that is used in this country is purchased from America and elsewhere, to an extent that is not only very serious but not creditable to the energy and

Nothing more clearly indicates the persistence of the qualities which have made Great Britain industrially great than the frank recognition, on the part of manufacturers in every

enterprise of the manufacturers. The same applies, in some degree, to agricultural machinery; but this is probably more excusable, as, for obvious reasons, the Americans have great advantages in making and developing this class of work. The remarks I shall make as to machine tools apply also to electrical machinery; but first, as regards the Atbara bridge.

The question has been gone into very thoroughly and some interesting letters have been published by Mr. Sell, in his "Commercial Intelligence"; roughly speaking, the story seems to be this:

That a bridge being wanted in a great hurry to carry the railway over the Atbara River, the engineers, who were responsible, made designs and sent enquiries to seven English firms. Being disappointed in the deliveries that were promised, they then appear to have made enquiries from American firms, and got a promise of a quicker delivery than any English firm could give, and (though this appears to be a matter of minor importance), at a lower price; and they gave the order in the United States. According to Lord Belhaven, the bridge was completed and inspected in America in 27 days.

Now, if it had been the case that the English builders were all full of work, and therefore could not undertake an urgent order, there would be nothing worth discussing; it would merely be an ordinary accident of trade; but Messrs. Westwood & Rigby, who tendered for this bridge, say that they were prepared to put the work in hand at once, that they made special arrangements to have the material rolled immediately, and that, in fact, the question of being busy would not have affected their promised delivery. We are therefore brought face to face with the fact that an American firm was able to build the bridge in less time than any English firm. But now comes another point. It has been generally stated, and not contradicted, that the Egyptian War Office had instructed their engineer to design a bridge and make a specification of a very elaborate character, which was submitted to Messrs. Westwood & Rigby, and presumably to other people. But this specification appears not to have been put before the American firms at all; they were allowed to tender on their own design, and this, of course, would give them an enormous advantage. Suppose that they had recently made a bridge of approximately

line, of the defects of the present British position. Everywhere there is full acknowledgment of any advantage possessed by rivals, and firm determination to secure and adopt any improvement, in machinery or practice needed to put England on as sound a footing as her sharpest industrial competitor THE ENGINEERING MAGAZINE rejoices in placing before its readers the conclusions of two leaders of reorganisation so prominent as Sir Benjamin Browne and Mr. J. Slater Lewis, the first of whose papers on Works Management for the Maximum of Production begins on page 59 of this issue. THE EDITORS

the same span, and to do the same work (and we may remark that at any given time probably some firm in England or America would be almost sure to be in such a position); they would then have a complete set of drawings, patterns, templates, and everything else; the weight of every part would be known to a nicety, and the men in their employment would all be exactly drilled, each one to take up his position to go on with the work without any delay.

Now, every engineer must know that if you repeat the same process over and over again, and especially if a large number of men are involved therein, the speed at which it can be carried out will be enormously increased, and the last article of any kind out of a large number may easily be made in the same number of days as the first one took weeks to complete. Whether any of the English manufacturers would actually be in the same position as the American firm, of course we do not know; but it seems quite clear that they never had the same opportunity of offering their own design. Very probably the Americans have more demand for large bridges and therefore were more likely to have the exact article "cut and dried."

Probably no rule can be exactly made as to what are the cases in which the engineer for a railway, or for anything else, will act more wisely in preparing his own designs, or in accepting those of the manufacturer. It is sometimes said, that if he is responsible for a design, he ought to make it himself; but this is really fallacious. It is quite clear that if a design, not his own, is submitted to him, he ought to investigate it and see that it is in every way satisfactory; but if he is a qualified man, he should be able to do this if anything more easily than he could make his own design, though, of course, it is not so flattering to his professional pride and does not bring his personality into the same prominence.

Now, where can we draw the line between the point where we ought to use standard designs, and the point where we should begin to use special designs? It is obvious that a large majority of railway bridges cross over roads or railways the width of which varies very little, and as there are probably hundreds, or perhaps thousands, of such bridges constantly being required in the world an engineer will, in most cases, do better to adopt an existing design, which has often been used and of which every possible weakness has been discovered by practical wear and tear, than to design something out of his own head. It will probably be better and certainly far cheaper. If a special bridge is required for an exceptional case, then clearly it is desirable for the best man that can be got to give his very best energy to de-

signing something as perfect as possible, specially suited to the case; the question is: where shall the line be drawn between the two?

There is no doubt a general feeling in the world that English engineers are too fond of their own designs, and too unwilling to adopt those of other people. In an article in *The Engineer* published on the 7th April, it was indicated that the influence of Great George Street, which is the headquarters of English consulting engineering, had injured our locomotive trade most seriously. What applies to locomotives applies also to bridges; and it is rather significant that the two great complaints of work having recently gone to America both of them concern railway work, and are therefore matters for which railway engineers are responsible.

The Engineer in this article went so far as to say that it considered the locomotive trade of England had been seriously injured by the consulting engineers of Great George Street, who would insist on each engine having exactly what they fancied to the smallest detail, so that the locomotive builder had no opportunity of building large numbers of similar engines for a market in the way that is followed by the Baldwin and other American companies. We may probably assume very much the same thing about bridges; at any rate, the two things, in some degree, go hand in hand, and probably no one, who is not in the trade, can realise the very great extent to which energy and enterprise are crippled if a manufacturer is compelled constantly to follow the caprice of one customer after another, and has no opportunity whatever of even classifying and utilising the information that he picks up from experience as he goes along. Of course, on the other hand, it may be argued that the business of the consulting engineer to a railway company is to get the best articles that he can conceive for his clients, and not to consider the general trade of England. This may be so, but our present business is to point out where the trade of the country suffers.

As we get from bridges to smaller articles, the desirability for working to standard types probably becomes greater. We now find some of our railway companies and some of the consulting engineers in Westminster ordering large numbers of engines from America. We believe we are right in saying that they are taking engines exactly to the customary designs of the Baldwin and other American firms which are manufacturing for them, and yet many of these same engineers, if they place an order in England, will not allow the manufacturer to make the slightest deviation from their conventional patterns in the very smallest article. Probably the chief reason why the Mid-

land and Great Northern Railways ordered engines in America was not that they preferred American types, but that they had, through short-sightedness and false economy, allowed themselves to run short of engine power and they were then compelled to do the best they could. I believe that the London & North Western went on building engines steadily all through the times of slack trade, and consequently have had no serious pressure on their resources now that busy times have come upon them. Of course, if Boards of Directors gave as much thought to the interests of the railway as they ought to do, they would also take care to have sufficient reserves of rolling stock and other plant to meet sudden emergencies, whereby they would not only get what they want a great deal cheaper, but they would serve the public a great deal better and make much larger profits.

But besides this, American engines have been ousting English locomotives from South America and many of the Colonies, to a very serious extent; this is probably not entirely on the question of American design versus European, because many of the English locomotive builders have made American-type engines at different times, and would do so again if they got orders; the fact probably is that the American engine is an extremely cheap one to build if made in large numbers. To take one point only; to make a small number of engines with bar frames where the staff and workmen have been always used to plate frames, will be expensive and troublesome until everyone becomes thoroughly accustomed to the change; but anyone who looks at the classes of engine building in an English works will be struck by the unnecessary variation in details—whistles, safety valves, brakes, axle boxes, guides, buffers, and all the endless minutiæ that go to make up a locomotive—which in far too many cases, have to be made absolutely to the instructions, or we may say the caprice, of the purchaser's engineer. This means keeping a very much larger staff of draughtsmen, it means the workmen taking much longer over the work, and probably practically means getting a somewhat inferior engine; because, if a manufacturer repeats an exact article many times, he very soon finds out every possible fault that can arise in connection with it. These can be all rectified and in a short time, whether the article is of the best possible theoretical design or not, it takes a form that can be absolutely relied upon not to break down or fail in practice. I fear that very often the consulting engineer likes to see his own personality on the work he orders and is really, without knowing it, working more to what he believes his own credit than to the benefit of his employers; but, if he could only see it, the official who is most

appreciated in the long run is the one who makes everything work smoothly, and who, if he scores no glory for himself, never has any breaks down but always has machinery in the most efficient form.

It is only fair to say that manufacturers themselves are very often very great sinners in this way. For example, if a new workshop is wanted, they put an ordinary draughtsman on to design it in all its details, though it would be probably far better and more cheaply done by some architect who made a specialty of this class of work. The same applies to cranes, and numbers of the other appliances often used in works. We have seen engine builders put up retaining walls and other structures of brick and stone which were simply lamentable exhibitions of ignorance, and such as even an average apprentice who is engaged on a dock or harbour works would see at once to be all wrong. So in the same way, a civil engineer who is preparing to undertake a large public works, the essentials of which he understands thoroughly, will go out of his way to make his assistants design cranes, waggons, and all sorts of things which he could far better have purchased ready made from people who make a specialty of these articles. I have known a resident engineer sent away to a remote country place, with an unlimited stock of drawing paper and stationery, but no designs and nothing to copy; and be there expected, either by himself or with some comparatively inexperienced assistant, to design all the numberless articles of plant that are required to initiate a public works. Now, not only is it a great waste of time and energy to think out on first principles, articles of which numbers of other men have made specialties, but also it is impossible for a man in that position to give to the perfecting of each detail anything like the amount of time that ought to be given. For an engineer to ignore the experience of other engineers in their special lines is as bad as for him to ignore the sciences of chemistry and mathematics, and all the invaluable maxims the knowledge of which constitutes the theory of our profession.

And a very important point is this. Whether in Great George Street, out on public works, or in the manufacturers' office, it is a great mistake to design hurriedly; for to put a draughtsman on to design a great many things, without full time to work them out exhaustively and to make them perfect, is to familiarise him with an inferior class of work, and accustom him to slovenly designing.

When we really talk of designing we ought to be able, first of all, to accumulate all the best information that exists on the matter we have in hand; then we ought to think the question out theoretically and practically, testing every step as we go, and not to be satisfied till we

bring out something so perfect that we cannot, by spending more time and thought, make any further improvement. I fear there is no doubt that in this matter the Americans see far more clearly than we do. You can find an engineering firm in America that makes only one type of lathe, and only one size of that lathe. Of course, the proprietor knows perfectly well that many other types are necessary, and many other sizes, but his business is to make that one type, and that one size, and make it absolutely perfect; if people want something else, they must go elsewhere. He sees at once that he cannot supply all the wants of the world, and what he wants is to have sufficient business for his own purpose, and in that to supply something better and cheaper than anybody else can give. I believe this way of doing business is eminently successful.

I believe it is much to be regretted that the old system of sub-contracting has become to so great an extent a thing of the past. There is no doubt that a man who contracted to supply labour, and employed his own men and boys, had a great deal of power in his hands and this power was occasionally very much abused; we have all heard the stories of cruelty in connection with the coal trade and the Staffordshire iron trade in olden days; but the same power that abolished the sub-contractor could have kept him in order, and were it not for better supervision, better feeling, and the men having better powers of taking care of themselves, abuse would creep in and cruelty and injustice would be just as prevalent under the present system as under any other system. It is a great mistake to abolish a system simply because bad things are sometimes done under it, and the advantages to the working classes of the middle man, or sub-contractor, were very considerable.

First, and by no means least, it enabled a man of ability and energy, without capital, to manage works, to make money by manufacturing, and thereby to save money and ultimately very probably to own his own works. Being also in and among the men, he knew their merits and demerits and had both the power and the interest to appreciate and reward merit in the most effective manner. His hands were not tied, as were those of a foreman, and he could therefore make bargains with individual workmen or praise or blame them just as he saw fit. It may be said that an employer might give his foreman power to do all these things but how few employers can, or will, do so. The employer would constantly have to be in his shop, instead of being in his office or with his customers, to judge as to the foreman's discretion; whereas the sub-contractor, who pays out of his own

pocket, has himself to please and pays the penalty of every mistake he makes. Besides, he would very likely devise means of making very large economies, and would thereby make such an income as people will not pay to a foreman, while at the same time supplying the manufacturer with finished goods at the same price, or perhaps a lower price, than they had been made at before, and relieving the manufacturer also of a great amount of labour and anxiety.

Those of us who have been many years in the trade can remember arranging with an individual foreman, or workman, to do so much piece-work and employ his own men. We remember how quickly he spotted the most paying men to take them into his employment; how keen they were to go, and how very willing he almost always was to raise their wages. This system still remains in use in such a case as that of the plater in a ship-yard, who employs a gang of labourers to whom he pays perhaps half again as much as they would earn in the ordinary labour market; and yet, though only an ordinary workman, will take home his 15 shillings to 20 shillings a day for himself; the fact being that if he and his gang put up five plates nobody could say that he had been exactly idle, and yet he puts up a sixth plate in the day, the profit of which goes entirely into his own pocket.

I should here like to make a short extract from "Chordal's Letters," an American book that is not so much read as it ought to be. There is therein a good description of a Yankee contractor—of how he comes into a workshop, sees the standard engine that the firm makes, and, without criticising its intrinsic merits, offers to make these engines at a very much lower price than they have ever been made at before. They have always cost the firm $510, and he contracts to make them at $400. The description takes up his processes, his re-arrangement of the details of the work, and his manner of approaching the men. He finds that one man has been paid $4 apiece for making the crossheads. Under the new arrangements, he is told he must make them for $1. The workman says that at $4 he could only make $1.25 a day for himself; so the contractor agrees to guarantee him something in excess of the $1.25; when the man gets to work, he finds he can easily make $2 a day, and the contractor lets him do so. The end of it is that the workmen make very much larger incomes than they made under the old system; the firm get their finished engines 20 per cent. cheaper, and the Yankee contractor makes extremely good money for himself.

I reserve for succeeding numbers consideration of the economies of standardisation and of labour's interests in the question.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

I.—THE EVOLUTION OF THE TOOL MAKER.

By permission of Walker & Boutall.

SIR MARK ISAMBARD BRUNEL.

Portrait by Drummond in the National Gallery, London.

TIME was when the general machine shop, with a mechanic of general knowledge at the head of its construction department and, for his subordinates, a force of thorough, all-around machinists, every one of whom was familiar with all ordinary machine-shop operations, was the only machine shop possible. In the year 1800 there were but few machines to be built; there were no ready means of communication, and the machine shop of that day, with its wealth of blacksmiths and hand fitters and wood workers, and its complete lack of anything even remotely approaching the machine tools of the present day, was forced to draw its trade from a limited area. Hence it was compelled to be general in the widest sense of the word and to refuse no order, no matter how divergent from anything ever before produced by the shop. Under these conditions, the best and most successful machine shops were those which had workmen of the most varied experience, and who could most readily adapt themselves to new lines of effort. These early machinists were of necessity men of skill; they were often fine hand workers, and every one of them was to some extent a tool-maker, capable of finding new ways to do the new things constantly placed before him, and of producing tools by which those new ways could be carried into execution. During the fifty years following the year 1800, the steamboat and the locomotive had so drawn the corners of the earth to-

gether that a world-wide market became a dimly visible prospect, to the maker of any one machine especially, but it is only within the last ten years of this century that it has become a common and everyday matter for a machine shop devoted to a single narrow line of production to find a market the world over. Hence, as ten years is a very short time for the acceptance of a new fact by the average human mind, there are yet only a few machine-shop managers who fully comprehend the results which are certain to follow narrow lines of specialization in machine-shop product. The short, but successful, existence of the special machine shop points clearly to the following conclusions:

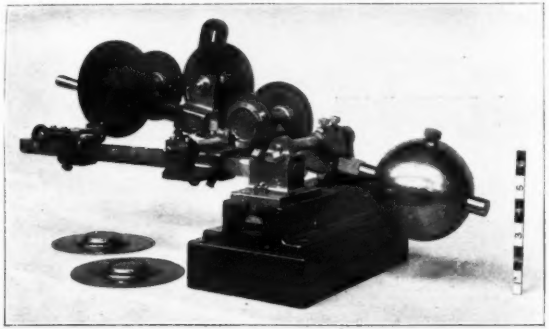
Machinists cannot longer be used to produce the commercial product of machine shops. The production of special types of machines of general application, such as locomotive engines, marine engines and gas engines, slightly varied from standard types, cannot be continued. The consulting engineer, whose principal function is the designing of machines slightly different from standard forms of any particular class, is no longer even a possibly economical factor of machine construction.

Commercial machines, that is to say, machines which are built to be sold and which constitute the saleable output of the machine shop, must be built by workmen who are not general machinists, but who, at the utmost, cannot rank above the skilled laborer, and at the least, may not rate above the wholly unskilled laborer.

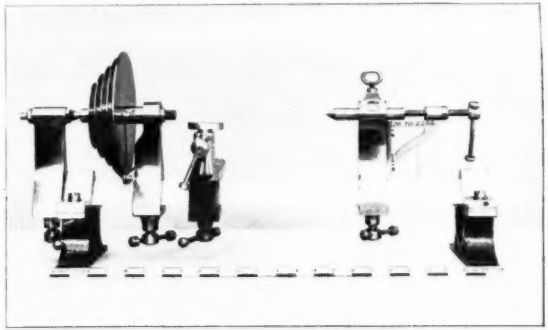
High-grade tool-makers, who are general machinists of the utmost degree of skill and reasoning powers obtainable, must now and henceforth devise the methods and construct the machines, to be used by the little-skilled machine-shop workman in the production of the commercial output of the machine shop.

Individuality of design must disappear from all machines in general demand. Not only must the minor inventor not appear in machine construction as the author of "specifications," slightly modifying standard machine forms, but the really original inventor must remain in seclusion, and unknown as the originator of a valuable advance in the arts, until thoroughly well-made commercial examples of the new thought can be offered to the purchasing public.

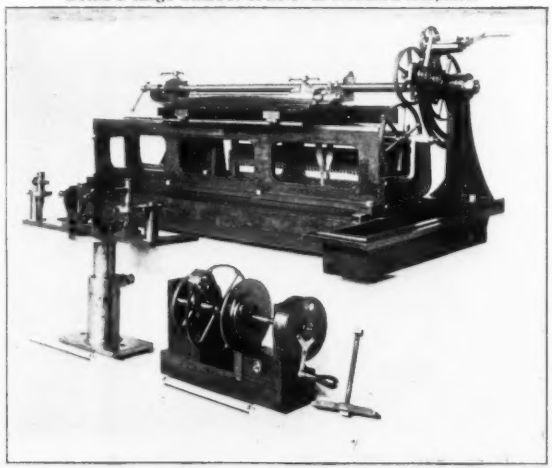
The reason why practice which always has been and to-day is common in the machine-shop, and by many machine-shop managers is still believed to be the only available one under and by which the machine shop can be operated, cannot continue, is that it is no longer commercially profitable to buy and use special types of



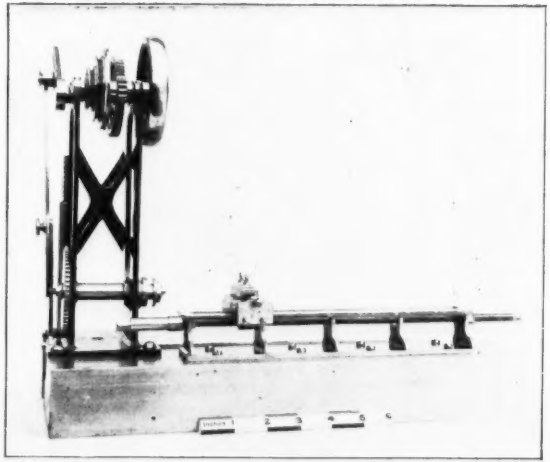
Drilling machine for watch plates. Patented by Roberts in 1846. Drills a large number of holes to standard template.



Bar lathe, made and used by Bryan Donkin, F. R. S. The bed is a triangular bar—the usual form for small lathes at that time.



Donkin's dividing engine, made by Bryan Donkin in 1826. It was also used for originating a remarkably accurate screw thread.

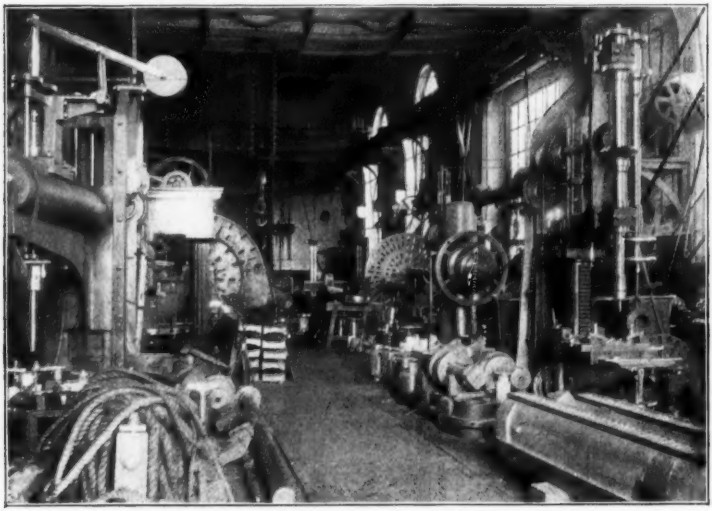


Segment turning lathe. Dates from about 1830. It is intended for turning portions of a cylindrical surface, such as crank cheeks.

OLD FORMS OF MACHINE TOOLS NOW IN THE SOUTH KENSINGTON MUSEUM, LONDON.

machines which are of general application; that is to say, machines which answer the requirements of entire fields of commercial effort.

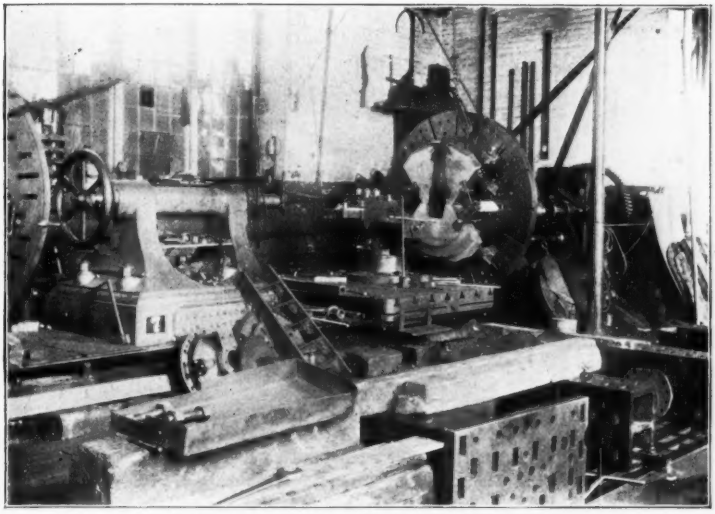
This last paragraph can only be true when the whole art of machine construction has so far advanced that really good machines for every commercial purpose are in regular production by machine shops having ample capital. More, all of the machines offered by the machine shops, as constructors and sellers, must be so superior in design and execution that no consulting engineer or other mere adventurer in any given art can, at short notice and small expense, produce a design having points of real advantage over the standard commercial forms.



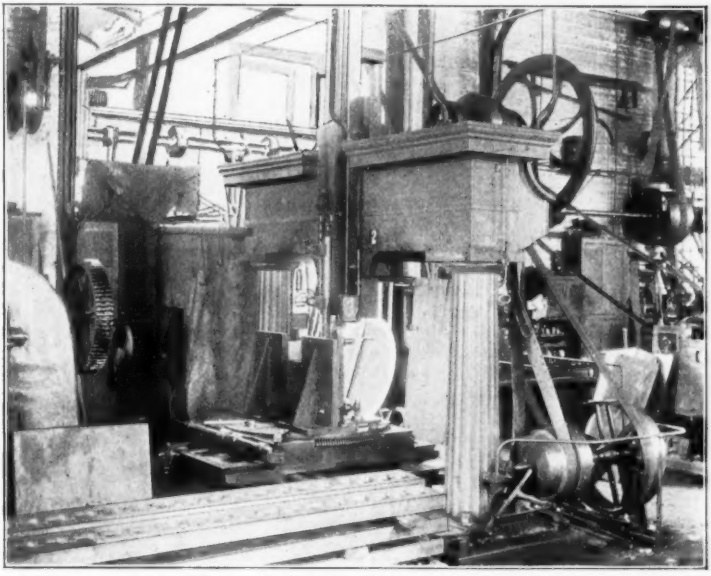
GENERAL VIEW OF PORTSMOUTH ERECTING SHOP, SHOWING OLD MACHINE TOOLS.

Examples: in small structures, the sewing machine, and the bicycle; in large structures the locomotive and the stationary steam engine. No material modifications of advantage can be made in the forms of these machines for ordinary and general commercial use. These papers do not consider the narrow and commercially unimportant fields of special use, in which minor invention will always be employed by wealth seeking occupation and variety.

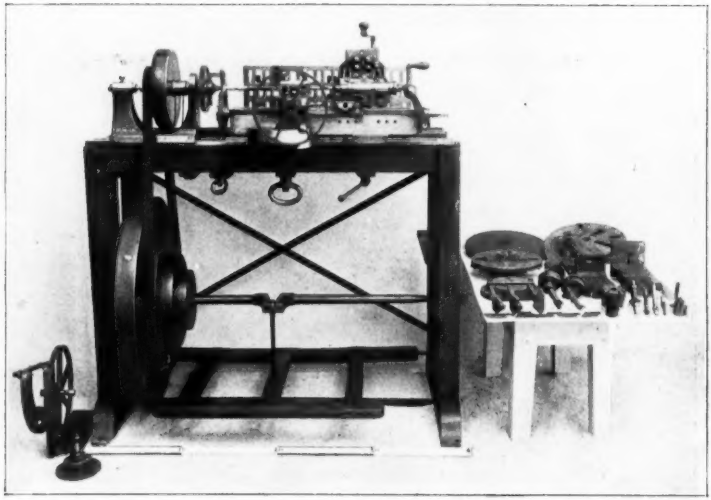
Individual impress cannot continue in any form of machine shop production. The operating force of the machine-constructing establishment, which is here spoken of as "The Machine Shop," must consist first of tool-makers, having such natural abilities and intuitions as



LATHE IN PORTSMOUTH DOCKYARD—NOT IN USE.
3 ft. 6 in. centers and 24 in between centers. Made by J. & D. Glasgow, 1850.

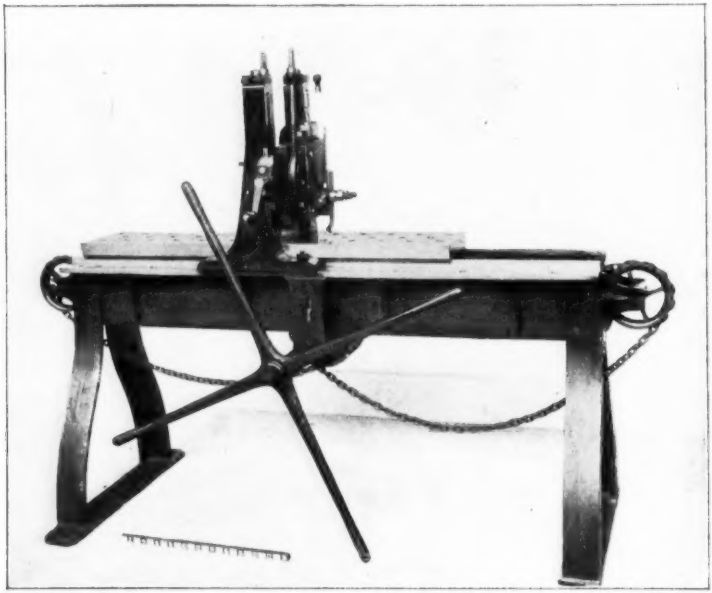


SLOTTING MACHINE IN CONSTANT USE IN GENERAL WORK, PORTSMOUTH ERECTING SHOPS.
3 ft. stroke, 12 to 20 strokes per minute; traverse of table, 4 ft. x 3 ft. 6 in. Made by J. & D. Glasgow, 1850.



TURNING LATHE, FORMERLY BELONGING TO CHAS. BABBAGE, F. R. S.

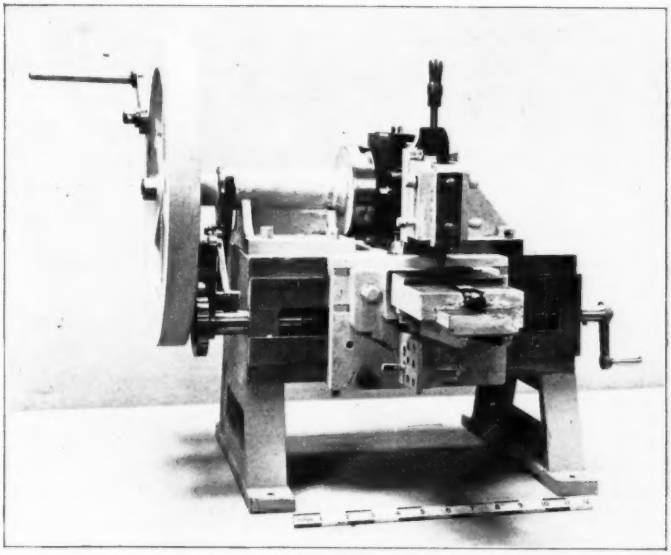
Now in South Kensington Museum. The slide rest is fitted with a face plate and clamps for holding work for milling or other similar operations. It is capable of motion in a vertical plane.



AN EARLY PLANING MACHINE, NOW IN THE VICTORIA AND ALBERT MUSEUM, LONDON.

This machine, made by Roberts, is said to be one of the earliest tools of its kind. Marks on the bed make it evident that it was itself made without the aid of a planer. The table is moved by hand, by chains winding on a drum; the headstock and tool traverse on a horizontal slide.

to enable them to produce, as a matter of routine effort, original and highly effective methods of machine production, together with the tools needed to carry out these methods; and, second, of workers who are in no sense mechanics, but who simply attend the machines produced by the tool-makers, and obediently follow the methods of machine construction laid down by the tool-makers. And there is no limit to the size of the machine upon which labor-costs can be reduced by the tool-maker.



SLOTTING MACHINE, FORMERLY THE PROPERTY OF JAMES NASMYTH.

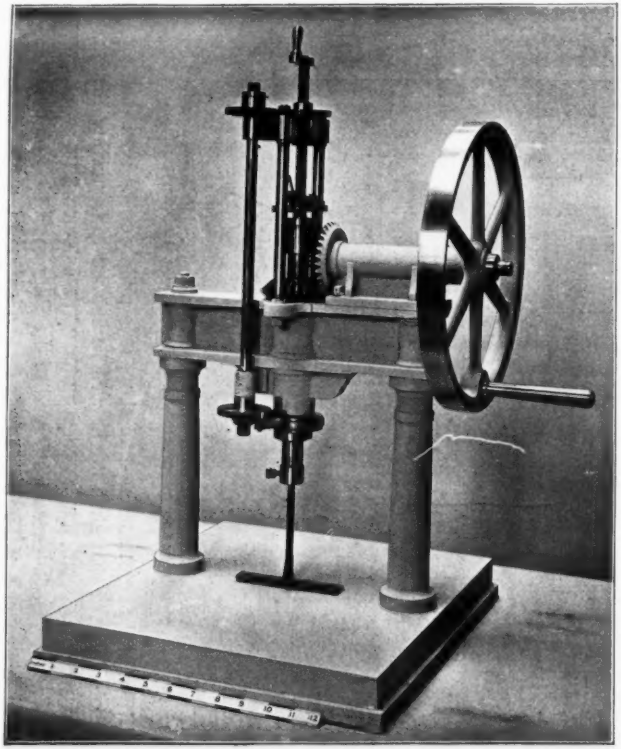
Now in South Kensington Museum. The crank disc on same shaft with the hand wheel has an adjustable pin in a T-slot, sliding on a block in a slot on the shaping head, which slides in Vs. The work is held by a vise traversed in V-guides by a screw, which obtains its motion either by hand or automatically by ratchet gear and links from an eccentric on driving shaft. The tool base has a vertical screw feed and is hinged.

The only machine shops which can continue to use thoroughly skilled machinists on any part of their commercial production are those which do not make two or more of the same machine at the same time, and the machine-tool shops, which often narrow their field of effort to very few different types, or even one single machine only, and hence have a commercial output consisting wholly of repetitions. In these two cases, extremes meet, and the strictly "general" machine shop, every day growing more rare, and the strongly specialized

machine-tool shop, which is constantly advancing in numbers and effectiveness, must both of them continue to use skilled mechanics on their commercial product. The general machine shop cannot place its production under the cheapening reign of the tool-maker, because an order for one machine of a kind at one time affords no economical basis for special methods and tools looking to decrease in labor-cost. The singly constructed machine must be made on general tools, by general workmen, at high labor-cost.

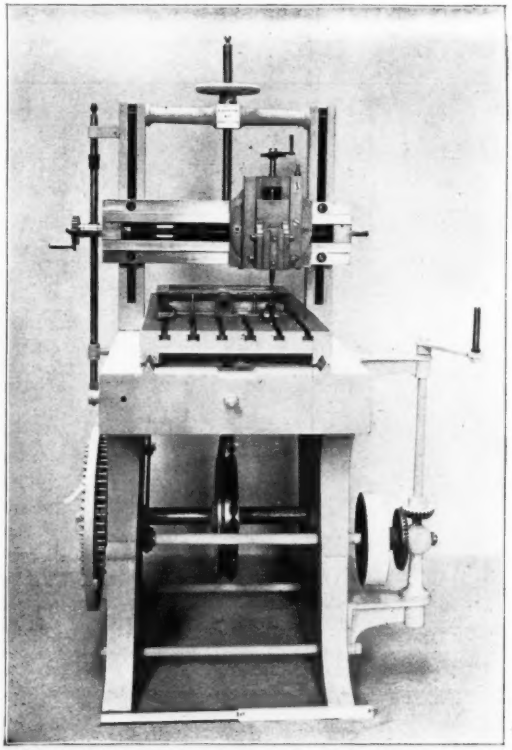
The machine-tool, on the contrary, must be of uniformly high grade and the special machine-tool shop has been so far, and probably always will be, of its own motion constantly lowering the selling price of its product. The excellence indispensable to the machine tool of permanent reputation demands a higher degree of intelligence and skill on the part of the workmen who produce it than can be had without natural aptitude and long training; hence every machine-tool shop must employ skilled machinists on a part, at least, of its commercial product. This fact does not, however, make the machine-tool shop an exception to the assertion that all successful machine shops must have the manual labor sharply divided into tool-makers and machine tenders. In point of fact, a machine-tool shop is not an independent individual machine-constructing establishment standing by itself. Industrially considered, the machine-tool shop must be held to be a part of the tool-room force of each of the machine shops which purchase from it. Thus, to cite the most common of instances, the machine shop which buys a lathe, a milling machine, or a universal grinding machine simply makes the builders of these tools a part of its own tool-making department.

It is worth while to dwell on this matter of close specialization for a moment. Suppose the whole world buys a thousand of some particular machine tool in a year. The customer feeling the need of this tool naturally applies for it to the most conveniently reached machine-tool maker whom he deems capable of producing a satisfactory article; under these conditions, each one of the thousand of these particular tools required might be built in a different shop, and in this case each separate construction would of necessity be treated as a passing matter, to which no great consideration could possibly be given, because the price paid would not permit more care, more thought, and more expense. The result of these conditions cannot be otherwise than inferior, because there is no possibility of recompense for the thought and labor needful to produce the best form of this particular tool. But if all of these thousand tools demanded yearly could



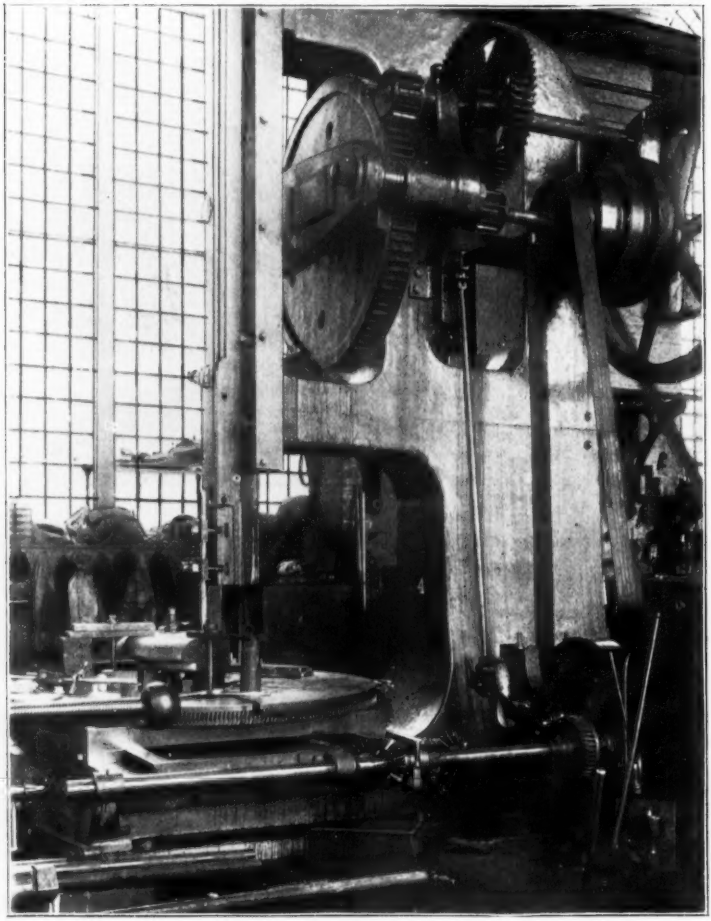
DRILLING MACHINE, FORMERLY THE PROPERTY OF JAMES NASMYTH.

In South Kensington Museum. Resembles the larger types made by Messrs. Nasmyth & Gaskell about 1840. The framing consists of two pillars carrying a cast-iron girder which supports the bevel gear for working the drill spindle. On this latter is an eccentric, which, by a link and ratchet, works a ratchet wheel on a second parallel spindle; this is connected, by equal spur pinions, with a screwed nut on the drill spindle, so giving the feed.



PLANING MACHINE, FORMERLY THE PROPERTY OF JAMES NASMYTH.

Built in 1857; represents the larger type made by J. Nasmyth & Co. about 1840. The small pinion on the driving shaft may be shifted from one side to the other of the pins with which it gears on the large pulley, thus giving the necessary reversal of motion. Chains from a drum on the driving shaft transmit the motion to a table with T-headed slots travelling on inverted Vs.



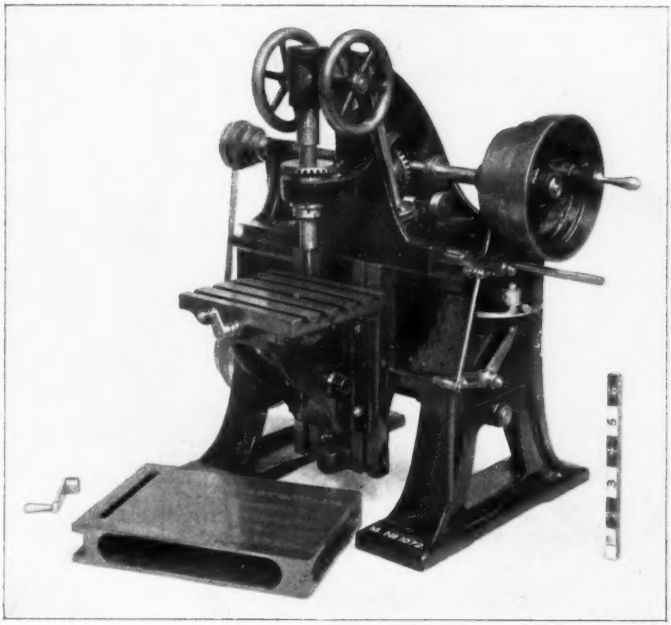
SLOTTING MACHINE IN THE ERECTING SHOP, PORTSMOUTH.

Used for heavy work. Stroke, 3 ft. 6 in.; traverse, 5 ft. 6 in. x 3 ft ; diameter of circular table, 7 ft ; makes 4 to 8 strokes per minute. Made by Collier & Co., Manchester, 1873.

be built in one single machine-tool shop, it is plainly to be seen that the whole force of that shop might well be applied to perfecting the product in every detail, and to cheapening while enhancing its value.

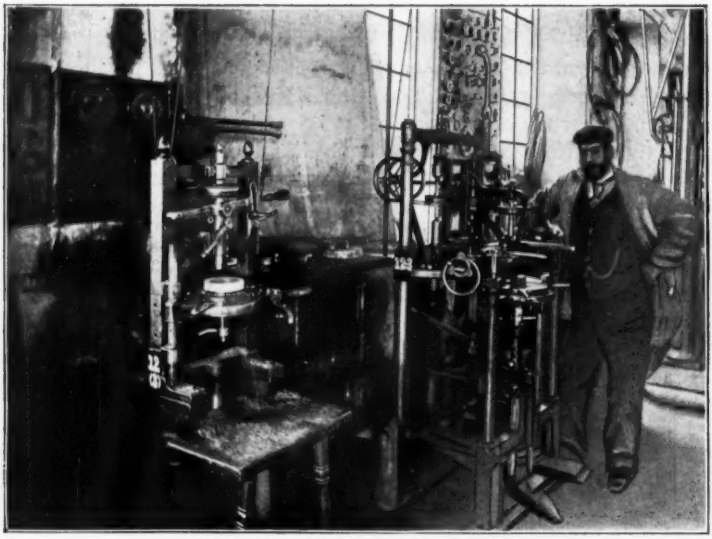
The whole case is Thoreau's legend of the Pilgrim of Koorou over again. This conceit of Thoreau's finds its application in machine-tool

construction. A valuable new idea once embodied in metal becomes immortal, and the tool-maker who, from some natural predilection or fortunate thought, is led to devote himself wholly to one production is absolutely certain of a market of greater or less extent, at least until a greatly superior device for accomplishing the same purpose is placed on the market. The chances of the production of a machine tool radically superior, say, to the present best forms of the index milling machine, are so very small as to be wholly inconsiderable. In the year 1800 there were no machine shops, no machine tools, and no machine-tool makers; at that time, any new form of tool which could be proposed was likely to be better than the primitive and inefficient forms in use. Now, in 1899, all of the possibilities have been attempted, and it seems quite safe to say that there are no radically new methods of

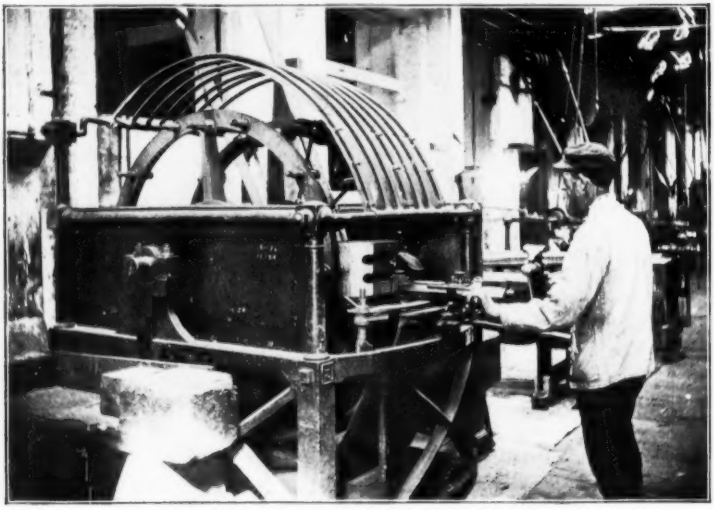


SLOT-DRILLING MACHINE, NOW IN SOUTH KENSINGTON MUSEUM.

Presented by the Institution of Civil Engineers, 1868. Slotted holes are cut by a revolving cutter, somewhat like a drill, travelling slowly over the required length. The headstock is made to traverse by an adjustable crank motion and connecting rod; the slow intermittent vertical-feed motion is given by a worm and worm wheel, driven intermittently by a ratchet motion acted on by a cam on the revolving crank shaft.



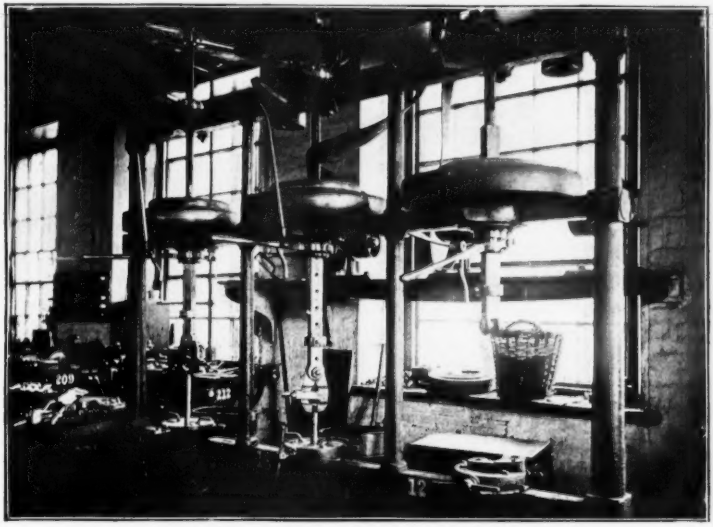
BRUNEL'S BLOCK-MAKING MACHINERY, PORTSMOUTH.
Coaking machines for pulley-sheaves.



BLOCK MACHINERY IN PORTSMOUTH DOCKYARDS.
Rounding and shaping machines for large blocks.

cutting and shaping of metals to be discovered. Hence the key to success is the ceaseless pursuit of perfection with known appliances.

In the case of the thousand machine tools, built in a thousand different shops or built in one single shop, the whole story is made perfectly plain. The shop devoted to a single production, or to a very limited line of production, must infallibly, because of the continued care and thought which can be given to every detail of its production, hold the market against the shop which pro-



BRUNEL'S MACHINERY FOR POLISHING BLOCK PINS.
In the Portsmouth block mills. The machine is now obsolete.

duces a great number of different machines, even though this shop may have far higher powers at its disposal. No invention is perfected in an instant; on the contrary, endless alterations and experiments are required to bring even the simplest of new mechanical conceptions into the absolutely best form. It is the constant and long continued application of thought which can alone bring perfection, and this is best obtained where few and narrow lines of effort are followed.

Asserting that the tool-maker is the first essential of machine-shop existence, it becomes pertinent to enquire when and where the tool-maker first became a distinct feature in machine construction, what

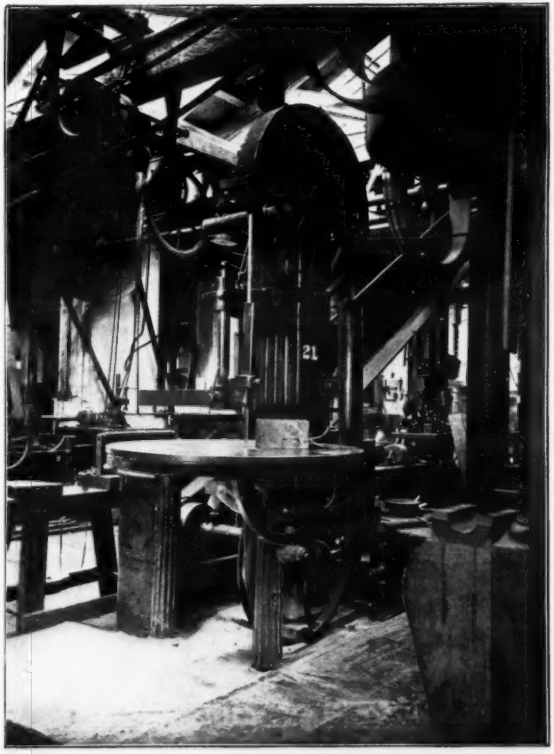
his actual and possible scope and influence are, and how he is to be distinguished from the skilled machinist.

Speaking narrowly, and within the lines of modern mechanical definition, the first individual to fully comprehend and formulate the possibilities of the tool-maker and his art was Samuel Bentham, who discovered about the year 1791 that intelligence may be transferred from the brain, or whatever, of the machine maker to the machine itself, to such an extent and with such permanence that the machine which the tool-maker has thus imbued with a portion of his own wits can subsequently, so long as it is in working order, supplement with this endowment the small mechanical skill of its tender. Hence the inventor of the method, and the tool-maker who produces a machine by which that method may be cheaply worked, are the most useful benefactors of the human race at large. The inventor of the method first, because he first finds some new thing desirable to be done; the tool-maker next, because he gives a machine such a portion of his own great intelligence as enables the machine to work the new method, useful to humanity at large, without much skill or intelligence on the part of the machine's attendant.

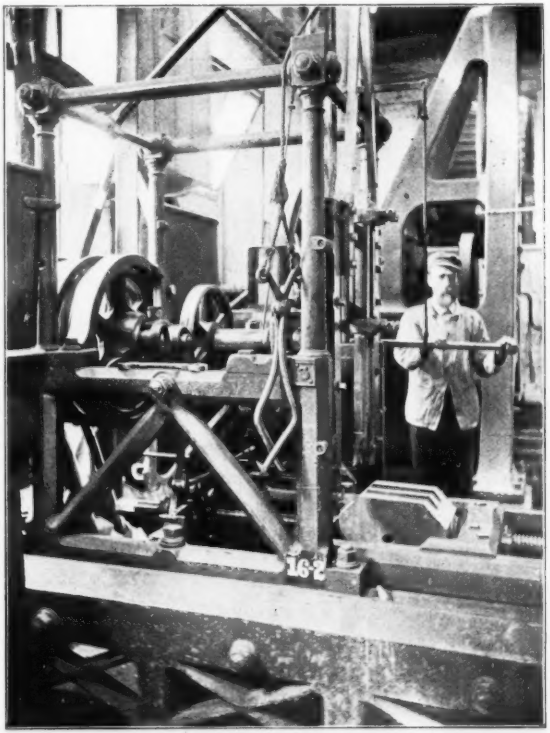
At this moment every step of the world's advance finds its foothold in the machine shop. All betterments of human existence begin in the conception of the new good, but must be made available for the use of mankind at large by the work of the tool-maker. If the tool-maker is competent to impart great intelligence to the new tool he produces, then the labor-cost of the new good at once becomes so small as to make many purchasers possible, and hence, through the great skill of the tool-maker, great benefits go to the human race. Because of all this, deep interest attaches to Sir Samuel Bentham as the first tool-maker to formulate distinctly the theorem that intelligence on the part of the machine maker might make both skill and intelligence needless on the part of the machine tender.

Previous to the time of Bentham there were tool-makers, because every mechanic is a tool-user, and tools must be made before they can be used; and it seems certain there must have been many individuals prior to Bentham to whom Bentham's theorem was familiar. But it was Bentham's fortune to be the first man placed in a position to make the large expenditures of money which alone could fully demonstrate the truth of this conclusion.

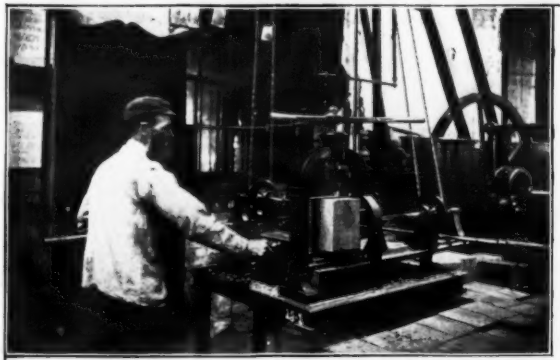
Space permits no more than the briefest mention of the early tool-makers and their achievements. The English tool makers were the first to enter the field of actual production of machines for sale by the



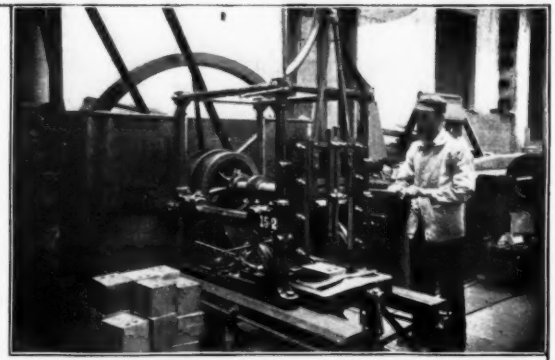
BAND SAW INSTALLED AT PORTSMOUTH ABOUT 1864.
Made about 1840, by Powis, James & Co., for Woolwich dockyards.



MORTISING MACHINE FOR LARGE BLOCKS.
Part of the early block machinery in the Portsmouth yards.



Horizontal boring machine for medium-sized blocks.
Boring machine for large blocks.



Block-mortising machines for medium-sized blocks.
Universal wood-boring machine of about 1820.

BLOCK-MAKING MACHINERY IN THE PORTSMOUTH DOCKYARD BLOCK MILLS.

aid of special tools, and the first to reach commercial prominence was Joseph Bramah, born in 1748. He was a carpenter by trade, afterward working as a cabinet maker in London. Bramah patented his famous lock, long supposed to be unpickable, in 1784 and 1798, and patented his hydraulic press in 1795. He took out patents on improvements in steam engines from 1801. In 1802 he patented planing machines for wood and metals, both rotary and reciprocating, and made milling machines for machining his lock parts, and invented stone- and timber-sawing machines. Henry Maudslay, son of a carpenter, born late in the 1700's, was an apprentice in Woolwich Arsenal, and soon became an expert workman. Bramah heard of Maudslay, and sent for him when Maudslay was only 18 years old, soon making him his head foreman, but, as Bramah would give him only 30s. per week, Maudslay set up a shop of his own, and was the first to make slide rests for metal-working machines of sufficiently good workmanship to show the possibilities of this device. Up to Maudslay's time the best machine-shop equipment known included hand lathes only, boring machines of rude construction, and vertical drilling machines, which it is needless to say bore little resemblance to the vertical drilling machine of to-day. Samuel Bentham, being authorized by the British Government to devise means for employing convict labor, selected the making of ship's blocks as a suitable industry. Bentham patented block machines in 1793.

Marc Isambard Brunel, born in Normandy, 1796, was an engineer by instinct and profession, but never was a practical mechanic. Brunel had considered the block-making problem and had taken out a patent on block-making machinery, and was associated with Bentham. Brunel accidentally heard of Maudslay, and submitted to him drawings of a portion of his block machinery, not disclosing its purpose, but asking Maudslay's opinion as to the mechanical fitness of the forms shown to produce the movements designed. This exhibition of details was thrice repeated, and at the third exhibit Maudslay said: "I see what you are after—you want to make blocks." Brunel then disclosed his intentions fully, and Maudslay produced the block-making plant after his own designs, both Brunel and Bentham being fully convinced of Maudslay's superior fitness. Maudslay began models of block tools in 1800, finished them in 1801, and they were promptly approved. Maudslay's time for the next six years was occupied in equipping a block shop with special tools, which had cast-iron frames, and much hardened-steel work entered into their construction. The first machine-made

blocks were produced in 1808. There were many machines in series, and in all no less than 44 distinct new machines of Maudslay's design in the block plant. With these tools, ten laborers were able to produce as many blocks as could be made by one hundred and ten skilled mechanics following hand methods. Maudslay was the first to attempt making screws of uniform pitch and diameter.

Joseph Clement, born 1779, was a natural mechanic, first a thatcher and slater. He neglected his trade to produce a lathe, a microscope and a reflecting telescope at the village smithy, and was afterward a graduate of Bramah's shop. In 1804 he took up the problem of screw making. After leaving Bramah's, Clement became chief draughtsman for Maudslay and Felds, and in 1817 began for himself, with £500 capital saved from his wages, which were at the best 3 guineas per week. Clement began to make taps and dies in 1828. Whitworth was one of Clement's workmen, and afterward adopted Clement's threads in his own practice, which became the English standard. Clement was the first to make a tap with a shank small enough to drop through the hole which was threaded by it. He had a planer at work in 1820, and a more elaborate planing machine in operation in 1824, with stationary tools and moving work, the work-table being carried on rollers.

James Fox, of Derby, England, a cutler, a natural mechanic, was established in the machine business by his master, and made a great success with lace and cotton machinery. He is said to have produced the first planing machine in 1814. This Fox planer had a bevel-gear table action. Matthew Murray, of Leeds, is said to have had a planer at work in 1814. Richard Roberts, born in Wales, 1789, a graduate of Maudslay's, brought out an improved screw lathe in 1816, and his planer in 1817, said to have been operated by "a chain and rack." Roberts was a very able mechanic and invented many machines, including the automatic spinning mule, and in 1834 began the building of locomotives on a large scale; he died in poverty.

This summary of a few of the greatest names must close the record of the early masters in tool-making. Samples of their work are shown in the accompanying engravings, obtained especially for these articles. For the unusual privileges accorded THE ENGINEERING MAGAZINE in this regard, acknowledgements are made to the courtesy of the Admiralty, for the Portsmouth views; to the officials of the Royal Victoria and Albert Museum, for photographs of tools at South Kensington; and to Messrs. Bryan Donkin & Co.

WORKS MANAGEMENT FOR THE MAXIMUM OF PRODUCTION.

By J. Slater Lewis.

I.—ORGANIZATION AS A FACTOR OF OUTPUT.

IN the engineering world, as in many other directions, the present is a time of transition. Under the stimulus of a wave of remarkable prosperity, old-fashioned methods of administration are beginning to show signs of wearing out, and of being no longer equal to the strain and intensity of modern industrial working. Very searching questions are consequently frequently asked as to the probable direction in which reorganization is required.

Prominent amongst these pressing questions is that of "increase of output." With every engineering works in the country strained to its utmost present capacity, this question is in many quarters of Great Britain a vital one, and whilst it is very easy for the merest apprentice to ask it, the answer is not deliverable in anything like simple terms. As the size of the average "works" increases, its problems tend to become complex in still greater ratio, and we find, therefore, that questions of equipment and of organization have begun to assume an importance in the general eye, as factors of production, second only to considerations of design and efficiency in the articles sought to be produced.

This has not always been so. Until quite recently the attention of engineers was almost entirely concentrated upon the latter. The commercial arm of the business and the drawing office have been the happy hunting ground of the principal intent upon progress, whilst the internal routine and administration of shops, save perhaps in matters of purely engineering practice, have been left in the hands of "practical" men, with whom rule of thumb is supreme, and who commonly regard with surprise and contempt any suggestion that their arrangements need constant watching and periodical revision; still more that it is possible to mould them on a well-directed theoretical plan, coupled with a system of record that enables their weak points to be detected and the results of modification instantly to be seen.

Yet when we speak of possible "increase of output," it is not difficult to see that the question is chiefly one of possible modifications in organization. Assuming for the moment that it is not merely tech-

nical superiority of one type of machine over another that is under discussion, then we may say that the question is *wholly* one of increased efficiency of organization. If we start from a point where the plant in use has already been modernised—although on that we shall have something to say later on—it is not unfair to assume that to the possible duty or output of that plant there is an ultimate theoretical limit, a maximum of work. But this maximum is not necessarily reached even under the most perfect organization. It might not pay—in many cases does not pay—to reach it.

As between two machines, one of which performs certain work in less time and with less upkeep than another, there can be little necessity for hesitation. The advantage of the machine that cheapens production as well as increases output is too obvious. But between extracting the maximum output from that machine and being content with a less output, very weighty considerations intrude themselves, not technical questions, but questions of organization. These considerations arise from the fact—which is of course known to everyone, but with exceeding rarity realised and given its due value in the economics of manufacture—that the price of doing work at a machine is *not* the wage paid to the man at the machine; there is another factor in the total price of the operation that is always of great, and sometimes of supreme, importance—the price of the organization.

To maintain a shop in full swing costs a considerable sum, and if every machine-man—*i. e.*, every man performing work by aid of a machine—were to give his services absolutely free, there would still be a price to be set upon every piece done, representing the charge of the establishment; this price would be high or low, exactly as the efficiency of organization was bad or good.

It follows from the mutual interdependence of these factors—cost of labour-hours and cost of organization—that with the former constant, *i. e.*, with a fixed time in which output takes place (say the eight hours' day), the total cost of the work will be strongly affected by any variation in the efficiency of organization. If, with the same total cost of organization, we increase the intensity of output, we have a less total price for our work; or if, with the same output over the same time, we decrease our cost of organization, we have again a less total price for our work. It will not be difficult, therefore, to allow the reasonableness of the claim we have to make, *viz., that in a close study of the relative efficiencies of organizations the key to future progress will be found.*

It may be admitted at once that, for such study, no body of data

exists anywhere at the present moment. Whilst as regards the bare operation of machine work—the time taken to plane, mill, slot or drill so many cubic inches of metal—data more or less approximate have long been in the possession of engineers, absolutely no record, or at any rate no standard record, exists by which the employer may gauge the comparative efficiency of the arrangements made by his foremen or works managers in all those important items of expenditure which lie outside of, and often bear no sort of relation to, the bare cost of machine work.

For a long time to come this will continue to be the case. Employers capable of taking broad views will no doubt gradually awake to the necessity for accumulating these data; but, until such practice is general, it will too often be regarded as a precious trade secret. Only by the more intense competition of those who have closely studied all the points of production, by means of careful organization and record, will the more old-fashioned employers be forced or frightened into doing likewise, and this information will gradually come to be looked on in the same light as data of technical efficiency, and will become common and similarly valuable property.

It is, of course, obvious that a study of the efficiency of organization is a much more complicated and difficult matter than the mere timing of simple operations. The factors entering into comparisons of machine duty are very few and certain—speeds, shape and angle of cutters, nature of material—all these are easy of reduplication, and variations in any of them can easily be allowed for. The comparative efficiency of various methods of attaining the same end—*e. g.*, planers, millers, turning mills, grinding machines—can also be studied by the technist with ease, and the results set against those of known experience. But when we widen the area of enquiry and wish to know *not* what it costs us to remove a given surface of material in mere labour-hours (*i. e.*, in direct wages), but to arrive at the actual, inclusive, and *real* cost of the whole operation, including the upkeep of the machine in a state of efficiency, the transport of the material from point to point, the share of supervision it obtains whilst under work, the amount of preventible loss and waste due to imperfect process-work necessitating costly hand labour to finish and make complete—*then*, so far as any possible comparison with the experience of others goes, we are at sea indeed. No employer is able to say to himself: "It costs me 5 shilling in wages to plane this slab, and 3 shillings and 6 pence—that is an additional 30 per cent. for cost of organization. This is bad because it is so much per cent. above the standard average." One

very frequently hears the question, "What do you pay such and such class of labour in your place?" but never "What is your percentage of shop efficiency?" Yet it should be obvious enough that the latter is the far more important question of the two.

"What," it may be asked, "is the exact meaning of 'efficiency of organization?'" Roughly speaking, it is the ratio of indirect and unproductive expenditure to expenditure on saleable goods or "stock." To place a machine in a shop and a man and a job at it appears very simple; but when we come to consider the case of 100 or 1,000 machines and men and jobs, it may easily turn out that the cost of housing the machines, looking after the men and providing a constant and even succession of jobs, together with the necessary maintenance of the plant in full working order, is the *larger half* of the total expenditure in that shop. But whether it be the larger half or no, its actual ratio to the mere wages of the man standing at the machines will depend entirely on the character of the arrangements made by those responsible for the routine—in other words, upon the "efficiency of organization." With thoroughly modern methods of handling material, keeping up machines to their full capacity, providing an ample supply of cutters and tools, dealing with stores and materials, issuing drawings and instructions to the men, working by jigs and templates and by "stop" machinery, sharp timekeeping and steady control and discipline, it is clear that the indirect expenditure will bear a smaller ratio to direct wages than where frequent stoppages for repair, absence of men grinding up their own tools, reliance on verbal instructions, lax discipline, and ancient and ineffective methods of marshalling, dimensioning, and gauging work are in vogue. In the one case the efficiency of organization is high; in the other, low. This is, of course, generally understood in a qualitative sense; the important point is that this factor of efficiency can be expressed quantitatively, can be represented by figures, and can be worked out graphically, so that the effect of new departures and experiments can be seen whilst they are in the making. And this leads us to consider how the efficiency of any given organization, good or bad, may be studied, and its strength and weakness made manifest.

To attain this end a complete and well-digested system of administrative record should be adopted. Not a mere amateur attempt at adapting an already existing system to local usage, but a carefully-thought-out method, based on the advice of an expert in this particular branch of work. It must not be supposed that to introduce modern

ideas in the midst of a conservative establishment is a task to be lightly undertaken. To adopt cut-and-dried methods is easy, it is true; but to educate those who come in contact with and have to work these methods is a more difficult matter, and only those with experience of the work this involves can appreciate the formidable nature of the undertaking. Notwithstanding these difficulties, the matter remains one of vital and imperative necessity. Modernity demands more than that the latest type of machine shall be installed in the workshop; it demands that a very precise knowledge shall be available of the difference the introduction of that machine has made upon the general efficiency of the undertaking. It demands that the organization, amidst which the machine is set, shall be as up to date as itself.

A great many persons entirely miss the point of advantage to be gained by a carefully-elaborated system of record in the internal administration of works. Old ideas die hard, and, since the cost of operations is still the principal element in such records, it is assumed that to produce more accurate "cost accounts" is the whole end of the reforms proposed. "Our costs are quite sufficient for us; we know what our work costs us in labour and materials; we know what to sell at," is the usual reply one gets when urging the utility of more modern methods. Now, apart from the fact that no system of cost accounts which *merely* registers material and labour is any trustworthy guide to the profitableness—or the reverse—of any particular "line" where the margin of profit is very small, or where widely-different classes of work are concurrently passing through the same shops, the object of modern methods of record is quite other than that of a system of cost accounts. That it fulfills the functions of this is quite true; but it has much more extended and even much more important aims.

The real object of modern organization is to strengthen the administrative arm in its control of routine, and to keep it closely informed as to fluctuations in sectional and departmental efficiencies. A modern system of record, at its best, is a kind of registering barometer, and the analogy is so close that fluctuations, in the one case as in the other, may be represented by a rising or falling line upon a chart as already mentioned. But there is this difference—and here the analogy fails and the advantage lies with the system, rather than with the instrument—that the former *tends to shape its own results.*

That this is so will be better understood when we have considered what demands on its managers a modern business makes, bearing in mind that, however wise and shrewd such management may be, it must, in a large undertaking, rest ultimately on two things—(1) the

degree and intimacy of knowledge conveyed to the management of what is actually going on in the works; and (2) the perfection of the arrangements by which the matured judgments, based on this knowledge, are realised and carried into the furthest details of routine.

The ultimate objects of a manufacturing business are the production of a given output with the least possible expenditure of direct wages and indirect expense, and its disposal in the market at a minimum of further expenditure. This, however, is a very bald statement. In practice many considerations occur to modify profoundly the race for lower expenditure—but this fundamental principle is never to be lost sight of, and indeed its modification is apparent and temporary rather than real and permanent. These considerations are of two kinds, affecting the manufacturing and commercial sides respectively. In both cases the welfare of the *organization* demands a certain amount of study and absorbs a certain share of nutriment for its upkeep. If we may adapt a physiological parallel, the health of the body generally must be maintained at a high pitch if the best results are to be expected from the applied functions, whether these be wood-cutting or war-strategy. Similarly, between the desire to produce and sell cheaply and the desire to evolve and maintain a high standard of organization, capable of meeting various and sudden demands and developments that may arise from unforeseen circumstances at any time, a true balance must be held, tending neither to stint and starve the organization for the sake of immediate results, nor, on the other hand, needlessly and uselessly to pamper it, so that it absorbs more than its proper share of the common vitality.

Thanks to the absence of data upon which to base comparisons, this point at which organization ceases to be an assistance and becomes a burden, a mere incubus draining the life out of an undertaking, is one which can by no means readily be defined. Every class of business, and almost every individual business, will vary in the ultimate degree to which organization may be usefully involved; but, generally speaking, all arrangements which tend to bring out into light of day or under the direct control of the management the aggregate effects of changes made in the conduct of the business, however trifling each of these may in itself appear, will prove of ultimate benefit; and by "changes" must be understood not necessarily special developments, such as the introduction of new machinery, but also all fluctuations in any of the factors which go to make up the totals of outgoings, and, not less important, of incomings.

That business is notoriously best served whose welfare is con-

stantly under the eye of a capable principal. But to the very possibility of such intimate personal supervision there are quickly found limits, beyond which reliance on subordinate responsibility becomes inevitable. Now, the true functions of a proper system or organization are (1) to prescribe, on carefully-thought-out plans, the directions in which each subordinate unit may most usefully exert his energies; (2) to gather and summarise, in graphic and visible form, the ultimate results of all these distinct channels of energy. Organization necessarily oversteps its mark and becomes superfluous when it fails to do either of these, or to present results in such pliable form that they present, to the mind of the principal, information on exactly such points as would, in a smaller business, be covered by personal attention and knowledge, and on some others of which we will now speak.

If we consider the details that a capable principal has under his immediate observation in a business small enough to be efficiently managed by personal supervision, we shall be able to enumerate some of the more essential points of organization on the larger scale. As buyer of raw material he is keenly alive to the relations between a rising or falling market and the costs and sale values of his products. He knows almost instinctively at what point economies neglected in busy times must be resumed. As payer of wages, he has before him constantly the ratio between his pay roll and his output. As a constant spectator of actual operations in the shops he is early aware of slack discipline, and can distinguish between well- and indifferently-managed departments. He takes personal notice of the extent of employment of his machines, of the effect of overtime or night work upon intensity of production, of the degree of repair in which his plant is kept, and of the consequent full use, or waste, of time incident thereto. Waste, in fact, of all classes is one of the points to which personal attention is most easily drawn. Even where the most elementary kind of costing arrangements are in vogue, the truth or otherwise of their results can be checked with sufficient accuracy. And with a practically fixed and unchangeable incidence of establishment or "indirect" expenditure, this latter most important item is understood by him in all its bearings as a matter of practice, if not of theory.

In all these cases, indeed, practical instinct, sharpened by the vital importance, to him, of the general result, will enable the shrewd principal to give a very good account of his undertaking. It is not even necessary (and in most cases it is not actually the case), that he shall have any theoretical perception of the bearings of these factors one upon another. These elements and relationships existed, of course,

before they were studied and supplied with names, and to a given extent no further complexity is necessary or desirable. But just as to lead a dozen men is within the powers of a corporal or sergeant, so, in the one case as in the other, as the numbers increase, does the necessity for a wider intellectual survey. To manœuvre a battalion requires a grasp of a number of points wholly absent and having nothing corresponding in the case of a squad. To the instinct and direct grip of personal supervision succeeds the power of directing an organization, and the two have perhaps not much in common. The head of a large business deals no longer with things but almost wholly with capacities; and it is towards discovering and employing to the full the capacities of those associated with him subordinately that all his arrangements must thenceforth tend.

It is because nearly all large businesses are the (often rapid) outgrowths of originally smaller ones that the question: "What is a suitable degree of organization?" can hardly be answered without reference to the circumstances of the particular case.

It is evident, however, that in addition to knowing all the prime elements of production present in a small undertaking, much more is required. For the first time the relations of these elements are no longer the subject of instinctive perception; they require to be placed artificially in juxtaposition, and in doing this mistakes may easily be made, and the whole trouble and expense of organizing be rendered nugatory, or the results even become dangerous and misleading.

It is not to the present purpose to attempt to indicate the lines on which organization should proceed, but rather to urge the importance of the fullest possible grasp of the principles upon which all good modern organization is based, and particularly to show that a mere "cost system," however essential to both large and small works, does not, and cannot, furnish answers, either in kind or in degree, essential to the highly-efficient administration of large ones.

To know when, where, and how economies may be effected, production stimulated, and the links of a prompt and efficient supply be tightened up is of the first importance. This involves a rigid departmentalising of the undertaking, and a separation at every stage of the "prime," the manufacturing, and the sale-organization costs. Between such independent departments, on the other hand, the most complete accord must exist, and their smooth interworking be made the subject of constant watchfulness and record. Time is of the most imperative importance in manufacturing operations, and a consolidation of the routine should be evolved, so intimate that deliveries can be forecasted

like the arrival of trains in a railway time table, really extraordinary circumstances of course excepted.

The *manufacturing* possibilities of a works, as apart from its engineering side, are becoming a subject of close study with all firms who have their eyes upon the tendency of the world's business towards further and yet further specialisation. Mass production and the standardising and unification of parts, with which it is of necessity connected, cannot be conducted save on lines of the most rigidly-exact organization. It is not merely sufficient that the technical portion of such operations be modernised. Automatic and stop-machines will not of themselves produce either a large or an exact output, but must be themselves made part of a system arranged to suit the changed conditions of work in order that their real superiority may become available.

There are some obvious points in which practice may be improved upon. It should be recognised that the internal organization of works lies neither wholly in the province of the engineer nor in that of the accountant. Primarily the object of such organization is for settlement of routine, and secondarily for recording the results of manufacturing operations. But, whilst the accountant looks only to the *final* result, the ultimate cost of every completed order, the engineer requires to follow not so much the final result as the gradual upcreep of detail after detail of expenditure by which that final result has been attained. Therefore, what will fully satisfy the needs of the accountant is of scarcely any value to the engineer. And, as a result of this curious position of affairs, this conflict of interests, the whole question of internal organization is the most undeveloped and backward section of the engineering industries.

In most places the accountant and his needs are considered paramount, and the application of clerical labour in work not directly involving the getting out of costs is looked on as a "fad." But not only is the predominance of this element hurtful to the due development of a proper system of organization, but it is often almost ludicrously the cause of great inaccuracies in the final results so sought after. In many places where the most elaborate bookkeeping prevails the question of *correct* allocation of time is one entirely outside the purview of the bookkeeper, and is left very often to the taste and inclination of the individual workmen concerned. A similar looseness not infrequently prevails as to dealing with stores. Yet it is obvious that the *first* effort of organization should be to collect the elements in a correct form. On the other hand, no greater error can be made than to multiply clerical work in the wrong place. The time of foremen is not to

be taken up with such duties, for obvious reasons; generally speaking, whatever arrangements are made within the shops should be made with a full sense that they must, to work satisfactorily, be accepted by those who have to deal with them as helps and not as hindrances. This is difficult, but it is by no means impossible.

At the risk of tiresome reiteration, the position with which we commenced must again be emphasised. The problems of the future are, in a sense never before reached, problems of organization. In whatever direction we look, whether it be a case of specialised output, of new methods of manufacture, or of simply increasing the efficiency of existing plant and methods, the necessity of studying the points involved by the aid of the most advanced and recent devices becomes evident. It is not enough to accumulate detail; it must be digestible detail. It is not enough to know roughly the cost in labour and materials of every article passing through the shops; it is necessary to establish a connection (and a well-thought-out and accurate connection, or the result will be misleading and disastrous) between every such article and the amount of indirect expense it may have incurred or absorbed on its way.

Loose percentages, or estimated incidences of expenses to costs, will no longer serve their purpose as a guide in the circumstances of intenser production which are being forced upon engineers. Distributions of actual expenditure over actual work, double-locked in every direction by financial balances; the abandonment of the old and clumsy device of machine-rating as a factor in cost-keeping; rigid separation of the cost of selling from the cost of making; a plentiful use of the graphic (chart) methods of representing what is going on, within and without; prompter and more automatic methods of allocating workmen's time to orders; the abandonment everywhere of verbal in favour of written instructions; greater attention to methods of securing the smooth interworking of separate departments—these are some of the directions in which advance is necessary and in which otherwise well-equipped and organized establishments are clinging to the methods of their forefathers, and without reform in which their best energies cannot be properly directed.

Reorganization is not, however, necessarily limited to administrative arrangements. The reward of labour, the reduction of the labour-factor itself, the fuller utilisation of plant, and the marshalling and arrangement of work, are all questions of organization in greater or less degree; but these, together with that of specialisation of output, must be considered in following issues of this Magazine.

ELECTRIC POWER IN ENGINEERING WORKS.

By Louis Bell.

MODERN manufacturing plants are, according to the nature of the product, very variously organized, but the basic principle of their industrial evolution is tolerably distinct. It is, briefly, to regard the whole establishment as a gigantic machine tool, enormously complex sometimes, containing many parts specialized for some particular duty, including some human semi-automatic feeds, belt shifters and conveyers, which are to be treated with the same nice consideration as the rest of the mechanism, but altogether constituting a well-regulated apparatus for turning out finished work. The superintendent directs the operation of the whole and the foremen serve as oilers and wipers.

This is not exactly a humanitarian point of view, but humanitarianism is seldom allowed to obtrude in matters of this kind, and we may as well recognize the condition as it exists.

Now, there are three principles of economy that underlie the efficient operation of any machine tool. First, keep it working steadily at or near its rated capacity; second, keep down friction, backlash and lost motion of every kind; third, keep down the manual labor—it eats into profits. It is not difficult to show that, in the practical application of these rules to the organization of a manufacturing establishment, the use of electric power may be—and is—a very important factor. I do not propose to deal here with any advantage that may come from using power electrically transmitted from a distant water power or coal mine, but merely with its application to the working of the industrial machine.

As regards keeping up the load factor, there are several distinct considerations involved. First, the mechanism as a whole should be kept at steady output every working day of the year; next, each element of the machine should be worked at load when it is worked at

all. In brief, the plant should have no periods of inactivity and no parts running idle. Unhappily, electric power can have little effect in the first particular, save as it tends in general to cheapen production, and, as a rule, the plant which can turn out goods most economically will be the last to shut down. But the usual cause of irregular operation is unscrupulous competition in the disposition of the finished product, causing very irregular demands for delivery, which fall with particular severity on industries in which the proportionate cost of material makes it burdensome to carry a heavy stock.

Such competition is almost as great an industrial disaster to the community as no competition at all.

In keeping up the load factor at any given time, however, electric power has again and again demonstrated its value. The subject has been threshed over many times, and each investigation has led to the same result, showing clearly that, by eliminating the waste power which comes from idle or under-loaded shafts and gears and slipping belts, through recourse to electrical driving, a very considerable saving in the net cost of power may be effected. The mooted point at present is not whether it pays to distribute power electrically, but what degree of subdivision of electric power gives the greatest economy. The weight of the evidence points to the use of a separate motor, not for every machine, but for each operative unit, whether this is an individual drill press, for example, or a group of a dozen automatic screw machines. Such a combination of group and individual driving greatly lowers the first cost of the installation, and gives, on the whole, better economy than the extreme plan of a motor for each machine.

Fig. 1, a group drive of spinning frames in an electrically-operated cotton mill, is a good illustration of a case in point. Here the ultimate mechanical unit is the spindle, and it is conceivable that a separate electric motor might be applied to each individual spindle. This would involve an enormous multiplicity of very small and inefficient motors. The next stage would be to apply a motor to each spinning frame—to which, in less degree, the same objection would apply. The method taken in this case, however, is to regard as the operative unit such a number of frames as, taken as a whole, will be in steady, continuous operation, and to assign a single motor to each group. In point of fact, the whole spinning room is an operative unit; but, as the number of frames driven from a single motor is increased, a point is finally reached where a further increase will result in more loss in shafting and belts than would be incurred by subdividing the motor units.

This sort of problem is the one which has to be solved in every application of motors to manufacturing purposes, but in this case it appears in unusually definite form. In machine-shop practice the operative units are less easy to determine. It is worth noticing, too, that in cotton-mill driving the electric distribution of power has the advantage of keeping the speed keyed up to the best working conditions all the time, by eliminating nearly all the creeping of the belts, so that,

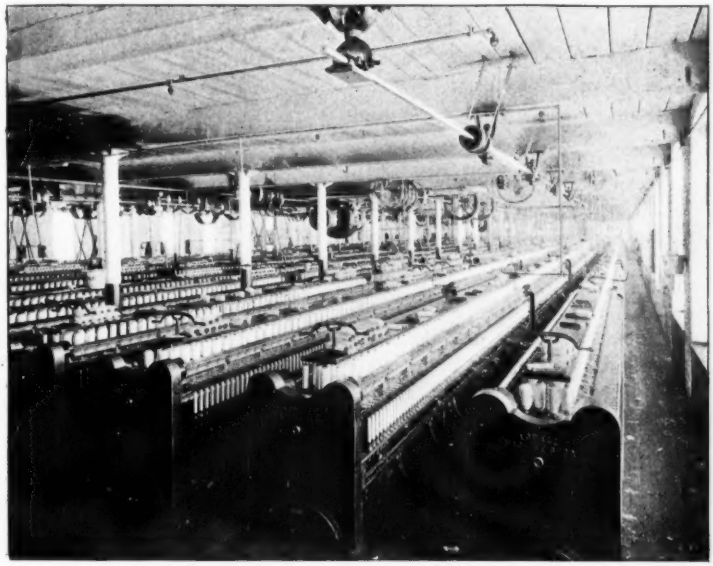


FIG 1. GROUP ELECTRIC DRIVE OF SPINNING FRAMES IN A COTTON MILL.
An instance of advantageous grouping of many small units for operation by a single electric motor.

as a matter of experience, it has been found possible to operate an electrically-driven mill at a slightly greater average speed than if power were distributed by shafts and belts, and hence to obtain a very perceptible increase of output.

Apart from this, the ability to run a few departments without working most of the shafting for the others is in itself often valuable. A case which recently came under my observation was that of a manufacturing establishment in which departments were successively shut down during a week of stock-taking. Starting with nearly full load, the useful work by the end of the week was trivial; but most of the shafting had to be kept in operation all the time. It is almost im-

possible to strike an average of the shafting distribution losses in large works. They may, and actually do, vary from fifteen or twenty per cent. to seventy or eighty. It is probably within the mark to say that, in most large establishments, the cost of power—and by this I mean the net cost—can be reduced twenty-five per cent. by the skillful application of electric driving. Each case, however, has to be considered by itself; the above figure is derived from personal investigation of a number of cases in which electrical operation was contemplated.

Far more interesting are those applications of electricity which have to do with avoiding lost motion—to speak generally. The immense amount of this which exists in many large works can be fully appreciated only by one who has been intimately connected with them. The machine-tool conception of the factory is beautifully efficient in principle, but it has one weak point which often escapes notice—and equally often leads to grievous results. And this flaw is the suppression of the feeling of personal responsibility in the human part of the mechanism. Carried to its logical conclusion, the prevalent idea of organization leaves, as mentally active agents, the superintendent, the head draughtsman, the tool makers or pattern makers, and the inspectors. If these last do their whole duty they may keep the product up to the mark, but they usually degenerate into a species of walking templet, and the product suffers. If each component part of an article is made by a workman whose only interest is in forcing out of his machine as many pieces as possible, good enough to pass an inspector whose work has become a feat of unconscious cerebration—the assembled whole is likely to be only passable, and the blame cannot be fixed on any definite victim. The best of which the system is capable is the production of a pretty good average. The same fault appears in every case in which the subdivision of labor is carried far enough to stifle the sense of individual responsibility. When the workman ceases to be a mechanic and becomes merely an operator on a No. 4 B, Schmidt Automatic Planer, adequate inspection begins to be costly, if anything but coarse work is in hand.

Furthermore, in large and highly specialized works it generally costs much valuable time to transmit an idea from the superintendent through the red-tape office to the proper departments. It actually is a fact that, in not a few thoroughly organized concerns, particular items of the product cost more to produce than when made in a small shop elsewhere. The point is that there is too much lost motion and too little responsibility involved in specializing all the mechanical

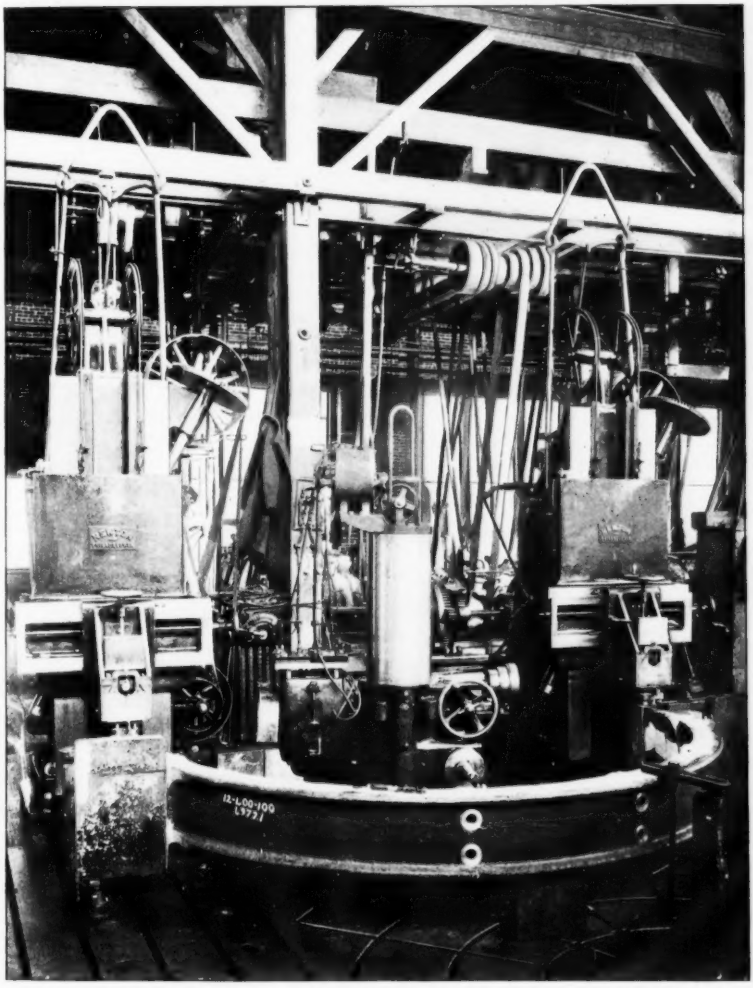


FIG. 2. PORTABLE DRILLS AND SLOTTING MACHINES AT WORK ON A DYNAMO FRAME.
An example of the gain in convenience and saving of labor through bringing movable tools to stationary heavy work.

operations, and better results could be obtained by putting the manufacture of that particular thing in a corner of the works by itself and holding the foreman responsible for the product.

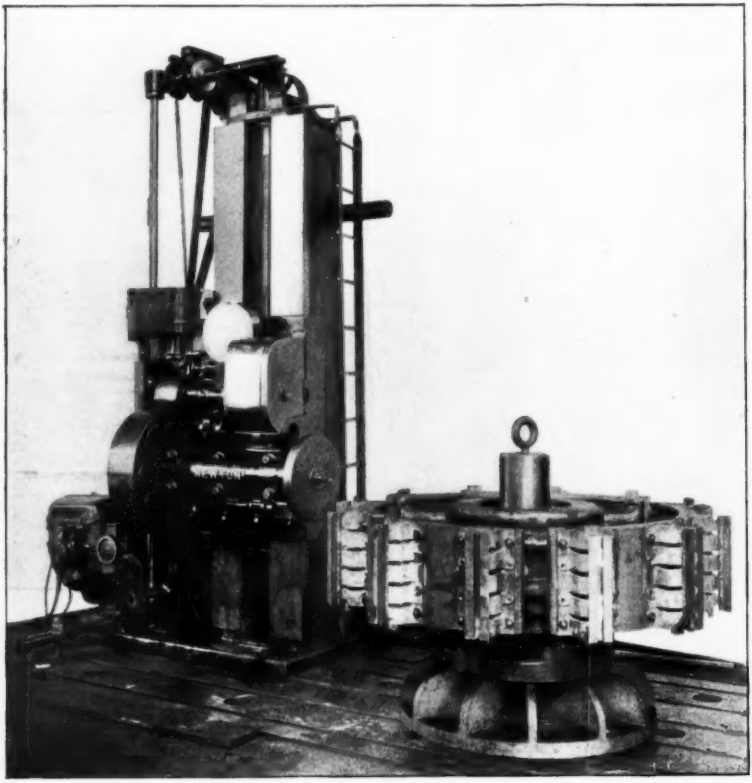


FIG. 3. PORTABLE MILLING MACHINE, DRIVEN BY A 12-H. P. MOTOR.

Another instance of the great convenience of moving the tool rather than the piece to be operated upon.

This digression on uneconomical specialization is a rather long text for a rather short sermon, but the truths set forth have been many times forced on my attention, and it often happens that shrewd applications of electrical driving can take up much of the lost motion and make it possible to secure cheaper work than could be done if the ordinary routine of subdivision were followed. In other words, one can take a short cut instead of going the long way around.

As an example, take the tool work done on heavy castings. Ordinarily, this taxes the resources of the biggest machines in the shop,

and I have often seen a big gang of men wasting an outrageous amount of valuable time in getting the work into position. In a properly equipped modern shop, the fact is recognized that it is easier to bring Mahomet to the mountain than the mountain to Mahomet, and portable machines are brought into play. Fig. 2 gives a good idea of their use. The casting is swung by an electric crane upon the nearest available space of iron floor, gridded like the bed of a planer, the tool is dropped into position by the same means, both are made fast, the motor is started—and the work begins. The machine shown in the center of the cut is a large portable drilling machine driven by a 3-h. p. motor, while on either side, made ready for work on the same casting, is a powerful portable slotting machine to which is attached a 12-h. p. motor. All three can be set at work together on the huge dynamo frame, once it is bolted into position, and can quickly be transferred to another field of labor when this particular job is completed. The result is not only an immense saving of time, but an escape from the necessity of putting an unwieldly mass through the regular sequence of machines ordinarily employed on smaller work. Where big work is to be done, there go the portable tools, leaving for the specialized routine the work which can profitably be assigned to it. Fig. 3 shows an extremely useful portable milling machine driven by another 12-h. p. motor, ready for work on a massive spider.

The great ease with which electric power can be distributed to portable tools makes it invaluable when very heavy work is to be done, and in big engineering works, ship-building yards and the like, it has so great advantages as to make its use highly desirable, quite aside from the absolute saving in cost of power. Even on lighter work similar tools can often be profitably used, and Fig. 4 shows a very convenient combined drilling and milling machine worked by a 3-h. p. motor and admirably suited to save time and labor.

In the construction of modern steel buildings there is an excellent field for the lighter portable machines, for current can nearly always be obtained from the street mains. In one instance, where portable machines could not be readily obtained, some deep steel beams were cut clean off by burning across with a powerful electric arc, and thus fitted to their places at a prodigious saving of time and money. For quick emergency work in contracted spaces and where proper tools are not at hand this arc process of perforating and cutting comparatively thin material is not to be despised; it is extremely simple and by no means so inefficient as it might appear.

In extensive works where the subdivision of labor is quite complete

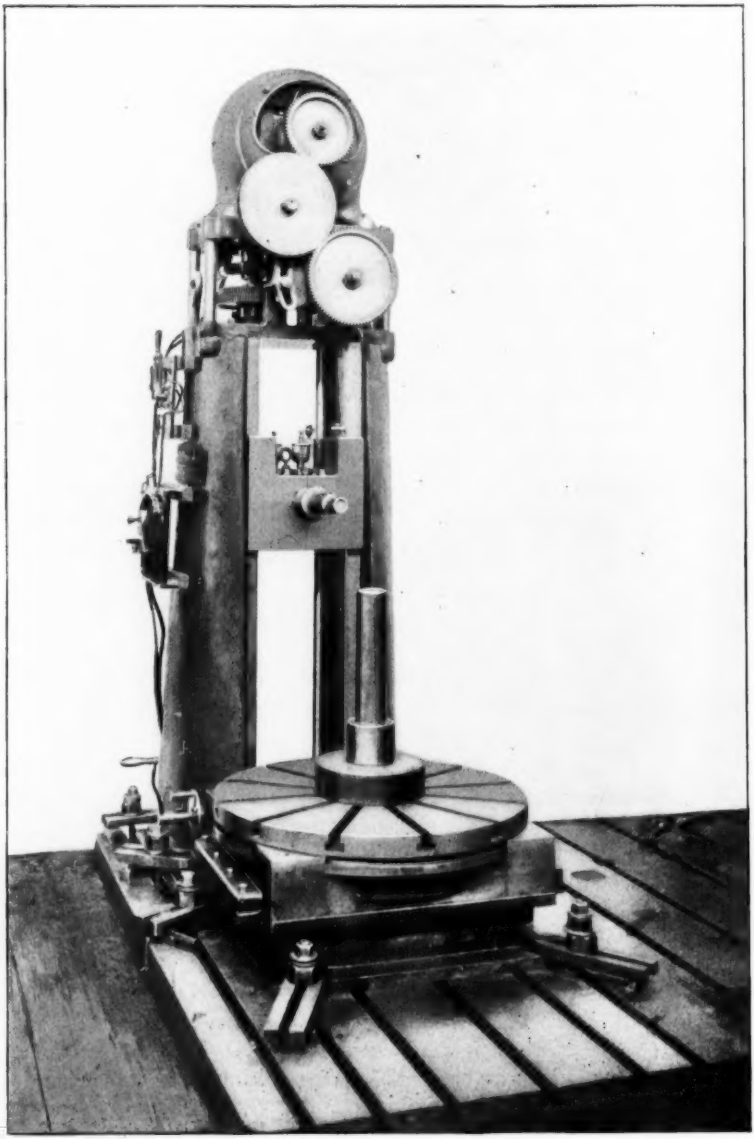
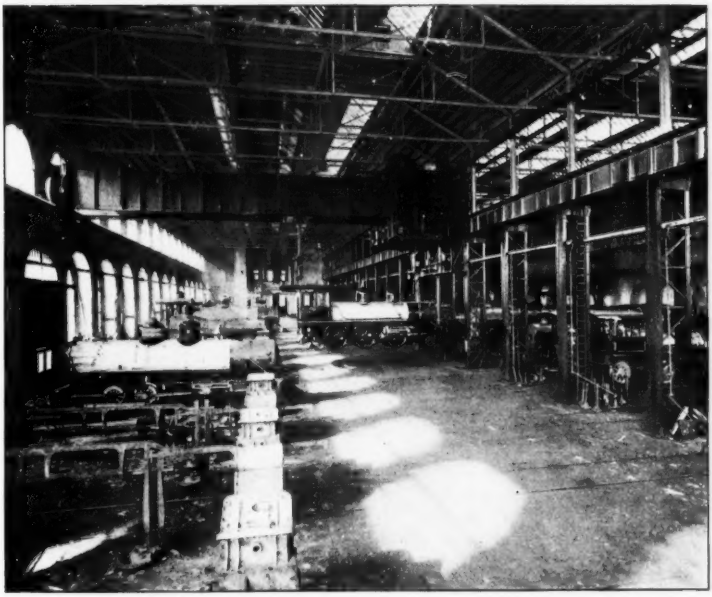


FIG 4. PORTABLE COMBINED BORING AND MILLING MACHINE, DRIVEN BY 3-H. P. MOTOR.



ELECTRIC CRANE HANDLING A NEARLY COMPLETED LOCOMOTIVE.
An example of easy internal transportation of heavy machines. The view is taken in the erecting shops of the Baldwin Locomotive Works, Phila., Pa., U. S. A.

it is very interesting to follow the peregrinations of a single comparatively simple article. Back and forth it goes from department to department, until, by the time it is completed, it has really been an extensive traveler leaving a long trail of tickets and receipts behind it. I once computed that a small bit of machinery had wandered about its factory yard about three miles, mostly in push carts, before it finally reached port in the shipping room. This routine is beautifully systematic, but expensive. Of course, it is necessary to have in every establishment some one who is possessed of a methodical devil, but means should always be at hand to confine his obsession to useful purposes.

A free use of electrical distribution, making it possible to work portable machines almost anywhere and to drive machinery economically all over the works, enables one to get rid of a vast amount of useless transportation. If the product is very varied, departments which are fairly independent may often advantageously be set apart

and worked under the close supervision of their own foremen, charged with complete control of the work and held responsible only for results. With portable tools at hand the machine work can be done very efficiently, and, what is of more importance, it can be done without a division of responsibility. To get a vivid idea of the other sort of thing, conceive a ship-yard in which every half-finished hull awaited its turn for transportation to the rivetting department, thence to be borne in triumph to the painting department. Yet, absurd as it seems, the same sort of thing on a smaller scale is part of the daily routine of

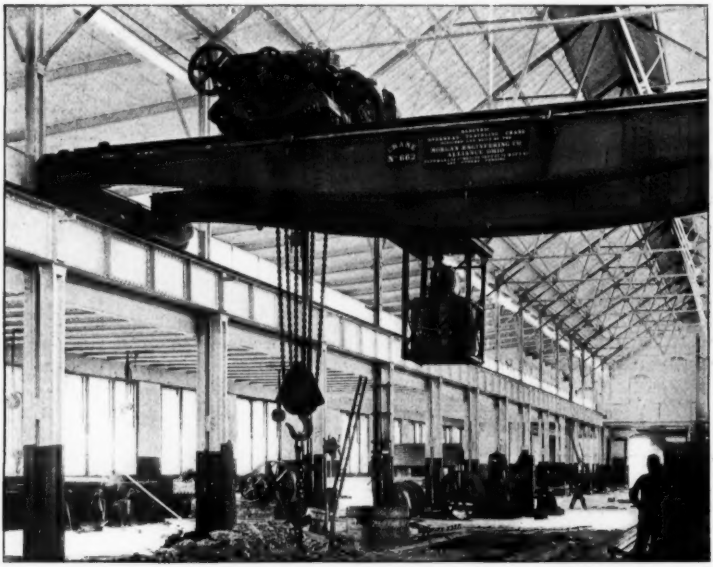


FIG. 5. ELECTRIC CRANE WITH LONG RUN, QUICK TRAVEL, AND ACCURATE CONTROL.

many a large factory. Some transportation there has to be, and there is now a very healthy tendency to equip all extensive works with electric cranes and tramways that replace hand tackle and push carts at an enormous saving of labor. It is hard to say too much for the valuable qualities of the electric cranes in particular. They are vastly easier to arrange for long runs, and to handle generally, than power cranes of any other sort, and the amount of labor saved is truly prodigious. Take, for example, the 30-ton travelling crane shown in Fig. 5. Although not of very great capacity, it has a very long run and

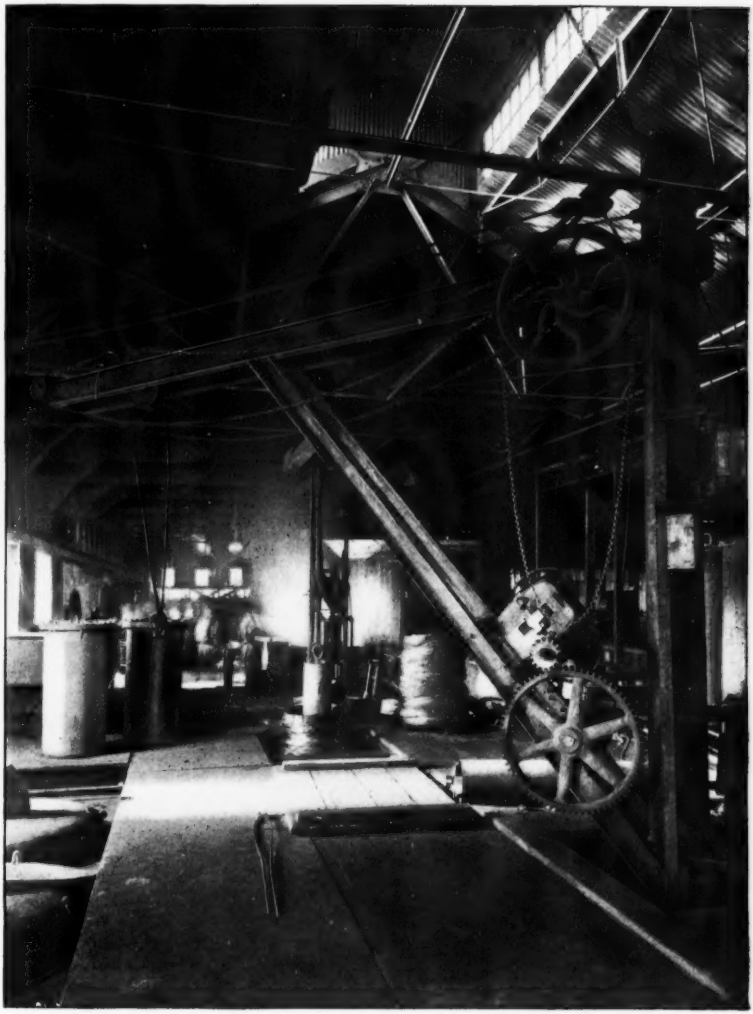


FIG. 6. ELECTRIC JIB CRANE IN AN ANNEALING MILL.

An instance of the style of installation which characterizes American plants, and which, in the iron and machinery trades, has so rapidly brought the United States into successful competition with the old world.

most accurate control, so that it is only a few minutes' work to land the heaviest piece of machinery the crane can handle in any part of the huge erecting shed.

Fig. 6 shows a large crane of the swinging type in the annealing room of a big wire mill. In works where heavy engineering work is done these and similar machines are coming into extensive use, and much of the economic development in the American steel industry is due to the promptness with which such auxiliaries have been installed. A mill with the appliances of a decade ago has a very small chance in competition with mills where ample power, under perfect control, is available for the quick transport and manipulation of every billet that goes through the works. It is the old story of hand labor, or crude appliances, against the most facile of motive powers applied with consummate skill. To such a contest there can be but one issue.

Almost weekly some new way of using electric power to replace manual labor is brought to notice, and the progressive manager keeps track of them, adding one or another to his equipment as it seems advisable. Now it is some new form of rapid lift, now a useful application of one of the electric welding processes, or again a special machine to cut down the labor in some simple process. All these come as corollaries, once granted the main proposition that electric power is at home in the works. As a whole, manufacturing establishments of the older sort are full either of small engines using 50 to 100 lbs. of steam per horse-power hour, or of belting and shafting always ready to consume power. Under such circumstances, the centralization of power generation alone is a very great saving. It is the old story of large units well loaded against small units under-loaded or used intermittently. The economy of the process is sufficiently attested by the thousands of horse power in electric motors operated in every large city, bringing power, too, from central stations, distributing current over widespread and costly underground systems at a good profit. While a plant in a single large works cannot turn out current at as low a figure as a big central station, the cost of distribution over the comparatively small distances involved is much less than in central-station practice, and power can be supplied to motors at a rate that means a very great annual saving. The first cost of the change from isolated engines to a central power plant and motors is, of course, considerable; but in the long run it pays. In one case investigated by me a clear net saving of $50,000 to $60,000 per year over all expenses, including interest and depreciation, could have been secured by the outlay of $200,000. The plant in question has recently been installed

on a somewhat smaller scale than that indicated, and the proportionate saving bids fair to verify the figure just given. Cases of this sort generally involve both the advantages of power production on a large scale and those attending the abolition of shafting and belting. No general rule as to the amount of saving can be given. As regards that due to increasing the directness of the actual drive, it is not uncommon to save one-fourth to one-third of the total power. The saving due to centralization is generally much greater than this, but of very varying magnitude, depending on the size, nature, and distribution of the units replaced. In working on a large scale, as in engineering works covering a considerable area, the cost per horse-power hour actually used can, however, not infrequently be halved. Wherever the total capacity of the prime movers is several times that of any one, economy indicates centralization, and the more numerous and smaller the separate units the greater the gain is likely to be. Of course a central boiler plant is frequently used, which is a material gain over separate boilers and engines; but, even neglecting the losses due to condensation in distributing steam, every horse power delivered from a small engine, of the sort usually found scattered about large works, means the consumption of two to four times the amount of steam needed to deliver the same brake horse power at the same points *via* the double transformation to electric current and back again. So much for the economy in consolidating the power production, aside from all the gains in shafting and belting, and those other less accurately defined, but most important economies in improving the methods of work and dispensing with manual labor. These last are of far greater interest to the mechanician than the mere distribution of power, and through them lies the road to future economic developments.

The saving which can be made by utilizing cheap power, electrically transmitted from distant water powers or coal mines, lies somewhat outside the limits of the present topic; but in many localities it must be seriously taken into consideration. Both in America and abroad good progress has been made along this line, and perhaps the most notable examples are the transmissions to the works of the General Electric Co. at Schenectady, N. Y., and to the Mercur stamp mills at Telluride, Colorado, in the United States and those of the Oerlikon works and the famous works of Escher, Wyss & Cie, both near Zürich. There are many other examples, of course, but these are especially striking. Of course there are plenty of cases of such transmissions on a small scale, or as a part of a large transmission system devoted to general purposes.

Aside from ordinary power work, there is much to be said for the practical advantages of electric lighting in all large establishments. Good lighting during the short days of winter, and on night work, is as essential to first-class results as are proper tools. A dingy, ill-lighted shop means a general sentiment of shiftlessness that cannot fail to react upon the workmen, quite apart from its actual inconvenience. Where a large shop electric plant is available, plenty of light and good light can be had at a very reasonable cost. The enclosed arc light is of particular value for this work, since not only does it require little attention, but gives a very soft and well distributed illumination. It is not saying too much to lay down the rule that the naked arc should never be used for interior lighting. It is far too glaring, and casts too sharp shadows for satisfactory results. Incandescents are exceedingly good in their way, but are unsatisfactory in large shops and when brought close over the work should be shaded and reinforced by considerable general illumination. Out of doors, bare arcs with reflectors to diffuse the light often facilitate night work astonishingly and save their cost many times over.

To sum up the case, experience now gathered from many large shops for some years past has shown: First, that by distributing power electrically and doing away as far as practicable with idly-running and under-loaded shafting, the gross amount of power needed for a given output is considerably reduced. Second; that by centralizing the power plant and distributing electrically, the net cost of the power for the given output is greatly decreased. Third; that by electric driving applied to special and portable tools and to means of transportation, the labor item in the cost of manufacture falls off to a notable degree; and finally, that special electric processes and electric lighting greatly facilitate the manufacturing operations and not only improve the output, but better the general *morale* of the shop, on which in the last resort, depends the ultimate economy of manufacture.

Dr Bell, in the paper presented above, shows very clearly the great gains which have been and may be effected by electric applications in the centralizing of power. In a second article, now in preparation, he deals with the remarkable, and apparently paradoxical, corollary—that electric transmission and electric driving enable *distribution* of industry, through putting the economies of centralized power generation at the command of the small power user. THE EDITORS.

THE OUTLOOK IN THE AMERICAN IRON INDUSTRY.

By Archer Brown.

A RISE of 100 per cent. in six months in the price of a commodity so universally used as iron is calculated to startle the world. It requires little sagacity to see that if present values are to be maintained for any length of time, a new basis of all industrial operations is rendered necessary. Will it last? How can it last? Assuming that 1898 prices netted cost to the makers, it would seem to follow that there is 100 per cent. profit in the manufacture to-day. Millions of capital are eagerly seeking investment where one tenth of that return can be assured. Why will not that capital rush in, start the idle furnaces and mills, build new ones, and quickly break down the markets by over-production? Again, will not new undertakings be checked by the high cost of structural steel, machinery, rolling stock, electrical equipment and the like, so that the great demand will soon begin to fall off, and the makers find themselves with more iron than customers?

Questions like these are universally asked by those who produce as well as by those who consume. The answer reaches far into economics—labor conditions, relations with foreign nations, transportation facilities, the physical limitations of mines, waterways, etc., the staying quality of the farmers and laboring masses in their power to buy needed things and pay good prices for them, the rapid increase of gold coinage in the world, and last, but not least, the capricious but powerful factor in all commerce and industry—human nature.

The facts of the rise in prices are fresh in all minds. In the first week in December, 1898, the larger interests in Alabama felt that the better demand warranted adding 25 cents per ton to the price of $7.00, then prevailing for No. 2 foundry pig iron f. o. b. cars Birmingham. It is a somewhat curious fact that, while Alabama produces less than a tenth of the pig iron made in the United States, it is her admitted prerogative to fix prices for the whole market. This is due, doubtless, to two causes. It is the cheapest center of production of raw iron in the world, and its product reaches nearly all consuming markets of

the United States, and even of Europe, on more nearly equal terms than that of any other district.

There was not much confidence in the improvement at first. There had been several false starts since the Baring failure in 1890 and the memorable panic of 1893, and nothing was more deeply fixed in the minds of producers and consumers alike than that the era of low prices was here to stay. Here and there a man had a memory and used it. But, for the most part, furnaces and mills sold freely on the first slight advance. When the price was up fifty cents a ton on pig iron and a dollar on steel billets and bars, furnace and mill owners joyfully took heavy contracts. When another dollar was added, along in January, many of the strongest and most conservative concerns in the United States booked their output for three, six, and even nine months ahead. At this writing (September) tens of thousands of tons of material are still going forward on these low-priced contracts. And to the honor of the trade be it said that, almost universally, the fulfilment of these low-priced orders is given preference over newer and highly profitable business. Here and there an unscrupulous concern has found the temptation to side-track the cheap business too great to resist, but these are rare exceptions to the general rule of good faith and business honesty.

The incredulity of the trade as to the genuineness and extent of the improvement had one conspicuous illustration in the highest quarters. The Lake Superior ore interests are counted the corner stone of the American iron and steel industry. The owners and agents centering in Cleveland, Pittsburg, Youngstown, and Chicago, thought prudence dictated a conservative policy, and opened their books in February at agreed prices averaging scarcely 25 cents a ton above the very low range of 1898. The ore was snapped up almost in a day, and before the bewildered sellers could tell what had happened, the vast product of all the Lake Superior ranges was sold for deliveries extending to July 1st, 1900. Stockholders of mines and other critics, wise after the facts, have wondered at a policy so very conservative towards the mine owner, and so highly liberal to the furnaces. In the light of subsequent events, it was a huge mistake. But it must be remembered and emphasized that, as late as March, only a man here and there in the whole trade showed, by his acts, his faith in the large improvement which was so rapidly to follow.

The following table will show the change that has taken place in prices of a few of the leading products in different markets of the United States:

PIG IRON.	Sept. 6, 1899.	Aug. 23, 1899.	Aug. 2, 1899.	Aug. 31, 1898.
Foundry Pig, No. 2, Standard, Philadelphia	$22.00	$20.75	$20.25	$10.50
Foundry Pig, No. 2, Southern, Cincinnati	19.25	18.50	18.00	9.50
Foundry Pig, No. 2, Local, Chicago	21.00	20.50	20.00	11.00
Bessemer Pig, Pittsburgh	23.25	22.50	21.25	10.00
Gray Forge, Pittsburgh	19.50	18.50	17.75	9.35
Lake Superior Charcoal, Chicago	24.00	23.00	22.00	11.50
BILLETS, RAILS, ETC.				
Steel Billets, Pittsburgh	37.00	36.00	34.00	16.00
Steel Billets, Philadelphia	39.00	38.00	36.00	17.75
Steel Billets, Chicago	....	36.80	36.80	17.00
Wire Rods, Pittsburgh	44.00	44.00	43.00	22.00
Steel Rails, Heavy, Eastern Mill	32.00	32.00	30.00	18.00
Spikes, Tidewater	2.35	2.30	2.00	1.40
Splice Bars, Tidewater	2.05	2.00	1.90	1.05

Without going into a tedious array of statistics, a few leading facts and figures are necessary to an intelligent knowledge of the problems outlined in the first paragraph of this necessarily general sketch. The history of the iron trade in the United States shows a persistent tendency to double consumption and production every decade. When the figures were small, in the years preceding and immediately following the civil war, it seemed no great thing to double in ten years. But when the statistics have grown to huge proportions, leading all the countries of the world, it seems like a geometrical ratio impossible to maintain. But if it is not made in 1900, it will only be because of physical limitations placed on production, not because the demand is wanting. The following figures will help illuminate the subject:

PIG-IRON PRODUCTION OF THE UNITED STATES BY DECADES.

	Gross Tons.		Gross Tons.
1859	750,559	1880	3,835,191
1860	821,223	1889	7,603,638
1869	1,711,285	1890	9,202,703
1870	1,665,178	1898	11,773,934
1879	2,741,852	1899 (estimated)	13,000,000

Stocks of pig iron in furnace and warrant yards in the United States in 1897 exceeded 1,000,000 tons. September 1, 1899, they had been reduced to about 160,000 tons, as the following figures show:

April 1, 1897	1,092,113
April 1, 1898	814,951
April 1, 1899	302,628
Sept. 1, 1899 (estimated)	160,000

It appears from Mr. Swank's tables that the consumption of pig-iron in the United States in 1898 averaged a little over 1,000,000 tons per month. In 1899 consumption is limited closely to the output, and may therefore be estimated at 13,000,000 to 13,500,000 gross tons for the year.

Going back now to the question "Will it last?" Frankly, it must be admitted no man knows. It is not given to mortals to unlock the future. War, famine, pestilence, Bryanism, may intervene and upset all calculations. But the wise man faces the facts as they are before him, and builds his judgment on these, discarding optimism, pessimism, preconceived theories, and even tradition. There were never better settled or apparently sounder commercial traditions in the past than that dollar wheat, ten-cent cotton, and ten-dollar pig iron (at Birmingham) marked the bottom limits in the great staples; but we became familiar with values scarcely more than half these, and men lived and prospered.

The simplest and largest fact in the present situation is a demand greater than the supply. What makes the demand? What limits the supply? The demand is great because seventy millions of people have pinched and economized for six or eight years, and now are quite able to buy, and what is of more consequence, are in a mood to buy. They have made the old stove answer, worn out the harvester and threshing machine, postponed the building of the county bridge, got along with the old stationary engine or lathe, put off the purchase of needed rolling stock for the railroad, hesitated to try conclusions with England in the building of ships, and generally have waited for the return of what is known as "good times." Now they want to replenish, from the sad-iron to the locomotive. Will they stop because prices advance? No, they will not. Here enters the element of human nature. Confidence breeds confidence. Distrust feeds on itself. Two years ago the great railroads of the United States could have renewed much needed equipment at about half the cost that to-day they do not hesitate to pay. Did they do it? It is notorious that the richest hesitated most. An amusing illustration is the case of a master mechanic of a great road whose requisitions underwent the usual cutting in two in the middle when they reached the management. Among the track and shop supplies needed was a large belt for an engine. When it

came it had suffered the usual pruning, and was just half long enough to reach. The writer will not soon forget an effort, in the summer of 1897, to find a buyer in New York for 100,000 tons of Alabama pig iron which a large interest was willing to close out at six dollars a gross ton, duly stored in a warrant yard—a price unprecedented in the history of the world. Not one of the great banking houses of capitalists dare fare the perils connected with such a proposition, though money was ruling at three per cent., and nearly free storage on the material was guaranteed. To-day almost any bank in New York would lend fifteen dollars a ton on it, and scarcely ask a question.

Buying, therefore, will not stop because prices are up. The railroads must have enormous additions to equipment, or lose the great harvest of profitable traffic. The millions of farmers will buy their agricultural machinery, stoves, carriages, and pianos, because crops have been good for three years, fetch good prices, the mortgages are paid off, and there is money in bank. Electrical equipment will not stop while street railways and lighting companies make large earnings, merely because dynamos and rails are dearer. Cities and towns will put in needed water and gas pipe without much regard to whether the cost is $18.00 or $28.00 a ton.

It is perfectly true that some new enterprises, that otherwise would take shape, are deferred because cost is found to exceed engineers' estimates. But this builds a reserve demand that will come in to support the market in the future. In high steel buildings, in large cities, for example, there is a distinct limit to prices that may be paid for materials without bringing the cost to a point beyond earning ability. The merchant marine can not be built up as rapidly from American ship-yards on $28.00 steel as on $16.00 steel. But these are but eddies in the main current.

The real factor in lowering prices will be in increased production, not diminished demand. How fast can the output of the furnaces be increased? I say not over fifteen to eighteen per cent. per annum. There was incredulity in as high quarters as Mr. Swank, Secretary of the American Iron and Steel Association, when this prediction was made early in the year. For were there not a couple of hundred idle blast furnaces in the country ready to blow in the moment profitable prices were reached? Would American capital or energy hesitate where the reward was so great?

It may be profitable to analyse the factors which operate to restrict profitable production. In a situation like the present they are clearly revealed, and many fine theories are upset by common physical

facts. Few people, who have not actually run a blast furnace, realize what it means to fill the capacious maw of one of those monsters with raw material. A stack of 200-tons daily capacity, running on 50 per cent. ore, must have delivered to it each day something more than 400 tons of ore, 250 to 300 tons of coke, according to the character of the metal required, and over 100 tons of limestone, besides sand, coal, and minor supplies—say 900 tons raw materials. Add the 200 tons of pig-iron product shipped out, and we have a daily freight movement of 1,100 tons, taking no note of the disposition of the slag. This is 55 carloads of 20 tons each. The mining of the ore requires the labor of 150 to 300 men, according to location; the coal mining, coke making, quarrying of limestone, and transportation, at least 300 more. The furnace itself employs about 150 or more hands. It will be seen, therefore, that starting up a furnace of ordinary capacity calls immediately for the labor, from first to last, of nearly a thousand men; for the use of at least a thousand railway cars and many locomotives; for perhaps several steamers and vessels on the lakes; for capital, from the mines to the pig iron, of one to two millions of dollars, and last, but not least, for a high order of managing ability, the scarcest of all scarce commodities, in times like these.

To use a concrete illustration, the Tonawanda Iron & Steel Co., located near Buffalo, operating two furnaces only, must unload at its docks one good sized ship-load of ore every day during the entire season of lake navigation, or fail to get down its needed supply. Another striking evidence of what it means to bring down the ore for the furnaces now running which depend on Lake Superior mines may be witnessed any day on Detroit River, where the loaded steamers and sailing vessels down, and the light craft up, crowd so close upon each other as almost to touch. Still another illustration, at hand as I write, is that of a small charcoal furnace on the lower lakes, needing about 80 tons a day, but unable to start because transportation could not be had for it. To add 1,000,000 tons, or say 10 per cent. to production, means the organizing, equipping, and starting of twenty such operations as described in the preceding paragraph.

The easy theory, therefore, that production can be turned on, as from a faucet, when profits are high, does not fit the facts. It is needless to say that every nerve will be strained to get into operation at the earliest moment the few existing idle plants, but those who base their calculations on an increase of not over 12 to 15 per cent. per annum in the next two or three years, will not go far astray.

It has not escaped notice that in all the present excitement, little is

heard of organizing companies to build new plants. Each of the great consolidations is planning additions to capacity, but there are few schemes to develop idle property, as was the case about 1890. There are reasons for this. The building of furnaces to sell town lots was generally disastrous. The impression is still abroad that there is a large reserve idle capacity. But the main factor in restraint is that, under present conditions, it would require at least a year and a half to build a good modern plant; the cost would be 50 per cent. greater than a year ago—and who knows where iron would be when the furnace was ready to start? The wisdom of the policy of building and enlarging in the bad times, followed for many years by Krupp and Carnegie, is demonstrated in a period like this.

What of the export trade? It is generally believed that this new factor is the all important one in sustaining American markets. Taking the iron and steel manufacture as a whole, I believe this to be true. But so far as ores, pig iron, and even steel billets are concerned, the movements has never reached 5 per cent. of the product of the United States and probably will not for years to come. Radical changes in the freight and labor situations must occur before America can capture English and European markets with crude iron. She is shipping liberally, it is true, and will continue to ship, for prices in Europe will always be regulated pretty closely by those in the United States.

But it is in the finished forms where American victories will be won, as they are now being won. In locomotives, wood- and iron-working machinery, agricultural machinery, nails, wire, bicycles and a hundred other lines, American inventive genius, great productive capacity, modernized plants, superior business organization, etc., will maintain and doubtless increase the great total of $80,000,000.00 reached last year in her iron and steel exports. The effect of this great and growing foreign demand is sensibly felt in every department of the trade.

The belief is widespread that exports from the United States must suffer a sharp check, if not come to a full stop, unless prices in America recede. This is a natural, but not well grounded, view. It assumes that the markets of the rest of the world go their way, irrespective of what the United States does. That was formerly the case, but it is so no longer. The world is now knit closely together in its industrial and commercial as well as its financial fabric. Influences that affect one nation are soon felt by the others. England and Germany were in the midst of industrial prosperity two years before it was felt in

America, but now that she has responded, the added stimulus is felt over there. We think it phenomenal that the mills and furnaces throughout the United States should have their product booked half through next year, but in Germany and Belgium they are already booked all through the year 1900. The great Krupp works at Essen, employing thirty thousand men, are filled with orders until 1901. Germany has nearly overtaken Great Britain in pig-iron product, but is nevertheless importing largely from both England and America to supply her deficiency. Great Britain shows a slackening in her shipbuilding industry, but her export trade in iron is again growing and all her lesser industries are exceedingly active. Prices of iron and steel have risen there almost as rapidly as in the United States. Middlesboro pig that sold last year for 43 shillings has reached 75 shillings and is now a little under 70.

The fact is the great industrial awakening is worldwide. China, India, South Africa, the Philippines, Japan, Russia, and the new island possessions nearer to the United States are full of projects for improvement. They have caught the renaissance spirit. The beginnings are small, but they suggest immense future possibilities. They want steam railways, electric lines, electric lighting, water-works, locomotives, machinery, bridges, etc., and it scarcely seems probable that having felt some of the benefits of modern progress, they will decide to turn back. America has shown her ability to compete with the other industrial nations for this trade, and will continue to get it in increasing quantity.

The world's consumption of iron grows in geometrical ratio. In 1740 it did not amount to one pound for each inhabitant. In 1856 it was about 17 pounds per capita. In 1890 it was 35 pounds per capita. In 1900 it will be probably 60 pounds per capita. The following table of consumption in the different countries proves the claim of iron to be the barometer of civilization:

	1856.	1890.
Great Britain	144 pounds	250 pounds.
United States	117 "	300 "
France	60 "	175 "
Germany	50 "	175 "
Belgium	70 "	175 "
Sweden	30 "	100 "
All the rest, say	6 "	12 "

In this connection the growth of the world's production of pig iron is interesting. In round numbers, this has been as follows:

In 1856	6,600,000	gross tons.
In 1867	9,300,000	" "
In 1878	14,100,000	" "
In 1889	25,000,000	" "
In 1890	26,500,000	" "
In 1900, estimated	35,000,000	" "

Of the last enormous total there is good reason now to believe that the United States will supply 40 per cent.

A word as to the new level of prices. It is too high of course to be permanently maintained. It is too high for the lasting good of this great industry. But we must not be misled by making false comparisons. The conditions reached in the lean years following the panic were abnormal, not natural. Iron was forced to $6 a ton at Birmingham on wages of 90 cents a day for twelve hours' work; on transportation rates that did not return the railroads' cost; and on destruction of royalties, or values of the ore and coal in the ground. The same was practically true in the Lake Superior district. It was simply a struggle for life. Values of great properties shrunk from millions to hundreds of thousands. Labor and capital fled to other fields. America learned great and valuable lessons during this trying experience, among others, how to produce iron more cheaply than has ever been done in the history of the world. Perhaps in the end the experience may prove to have been a blessing. But we must not make the error of supposing that those were normal conditions, and that when we have escaped from them we are on an artificial basis. A sound view is that we are nearer normal conditions to-day than we were when 100,000 tons of $6 pig iron went begging for a buyer in New York. A cent a pound for the best pig iron in the world should not, after all, paralyze the faculties of reasonable persons.

It should not be forgotten that the cost of iron resolves itself substantially into three things: labor, transportation and royalties, or the value of the material in the ground. Labor, the largest item, is up 25 to 40 per cent. in iron making. It is not yet too high for the good of the country. Transportation is up about as much, but who shall say the stockholders of the railroads and steamship lines are not entitled to a few dividends after years of waiting? It is now possible to credit ore and coal mines with something for the materials in the ground. But is it a violent assumption that the great iron and coal deposits of the United States, which are usually counted the foundation of wealth in an industrial nation, are actually worth something and should return a profit to their owners on material mined out? If

these points are conceded, the legitimate cost of pig iron in the United States is at least 33 per cent. above the low level to which it was forced in the years from 1895 to 1898. The manufacturer's profit, if any, must be added to this. It is some satisfaction to know also that cost is rising proportionately in other parts of the world. In Great Britain and Germany the increase varies from $2 to $4 per ton, according to kind of metal and locality where it is made. This is due mainly to the steady rise in the price of coke, although ores have advanced and are in short supply.

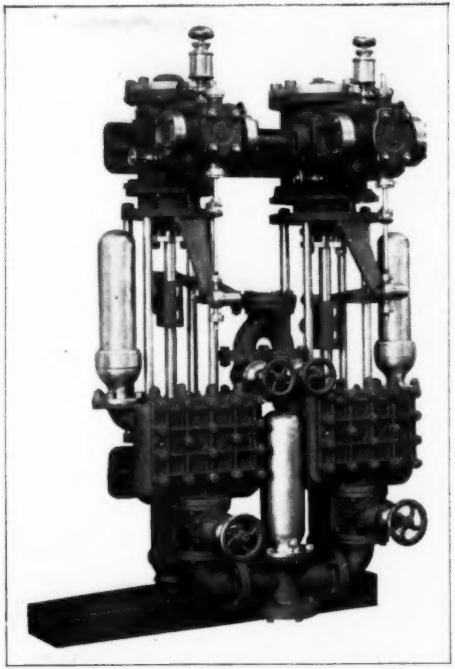
Cautious investors as well as manufacturers quite naturally look forward to the time when collapse will again take the place of boom, and prices will drop below cost of production. Who shall stand against that day? The strong, who expect to survive, are taking extraordinary measures to equip themselves for whatever may happen. The huge consolidations—at least those newly organized—are free from bonded debts, with large provisions for working capital. Some of them indeed are lenders of money in the street. Nearly all have strengthened themselves by ownership of ore mines, coal mines, coke ovens and even transportation lines, so that they are independent "from the ground up." If the time ever again comes for a fight for existence, it will be between giants indeed, and no other nation can resist American inroads. But every observing man has noted, in the instructive years of the past decade, the wonderful tenacity of life of small plants well located and economically managed. Another thing that has not escaped notice is that in the "survival" struggle, there is a marked tendency to equalize conditions in all the different districts. It is a fact capable of demonstration that the best returns on capital during the lean years were not from the great concerns in the most favored locations (barring one or two exceptions), but from certain smaller operations located in districts not usually spoken of as the cheap centers of production. It is a safe assumption, therefore, that, whatever lengths the consolidation movement may extend to, there will be plenty of strong undertakings on the outside that will keep the industry on the sound footing of free competition.

THE USE OF STEAM IN AUXILIARY MACHINERY ON WAR-SHIPS.

By Lieut. John K. Robison.

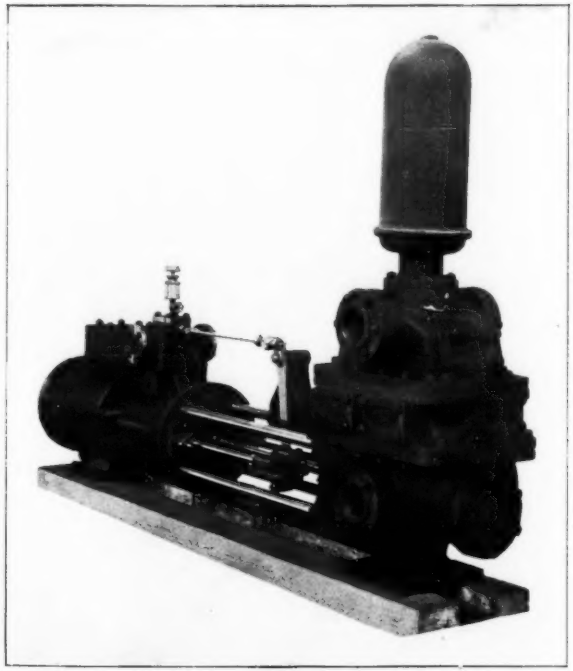
THE article of Mr. Dickie before the American Society of Mechanical Engineers some years ago has been followed by probably twenty others advocating the adoption of a central power-plant for the distribution of electric, hydraulic, or pneumatic power to the many auxiliaries of a war-ship. This question seems latterly to have narrowed down to one as to the advisibility of installing electric motors for operating the auxiliary machinery, these motors to be run in connection with a central electric-power-plant of proper capacity. The suggested arrangement is peculiarly attractive to many engineers, as seeming to be along the line of progress that has been successfully followed on shore. Every one realizes that the conditions on board ship are very peculiar, and that so many elements enter into war-ship design that the whole ship, to be homogeneous, may contain many apparently bad features. Yet electricity is now so extensively adopted in a commercial way, for power purposes, and such great gains have resulted therefrom that, on the face of it, the use of electrically-operated auxiliaries appears more than feasible on shipboard.

Every question of the use of electricity must be decided on its own merits; all the conditions must be duly weighed before a reasonable decision can be reached. What is good practice for a machine shop may be very poor for a silk mill, and electromobiles may be best in a large city but out of the question in localities where there are no facilities for charging the batteries. The conditions obtaining on war-ships differ materially from the commercial conditions in average plants. Weight, an important factor on shore, is vital on shipboard; while capital outlay, with the Government's three per cent. interest charges, cuts a small figure on naval vessels. The question of elec-



VERTICAL CROSS-COMPOUND MARINE FEED PUMP.

One 6 x 3½ x 8 and one 9 x 3½ x 8 simplex, arranged to run together as a compound, or either alone as a single pump. Geo. F. Blake Mfg. Co.

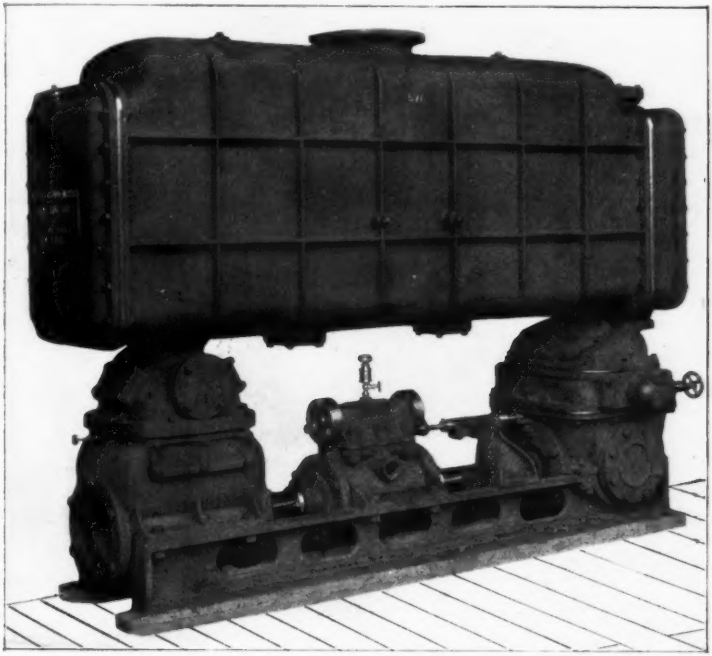


HORIZONTAL TANDEM-COMPOUND MARINE PUMP.

The low-pressure steam cylinder is in the rear, and transmits its motion to the crosshead by the two outside rods.
Made by Geo. F. Blake Mfg. Co.

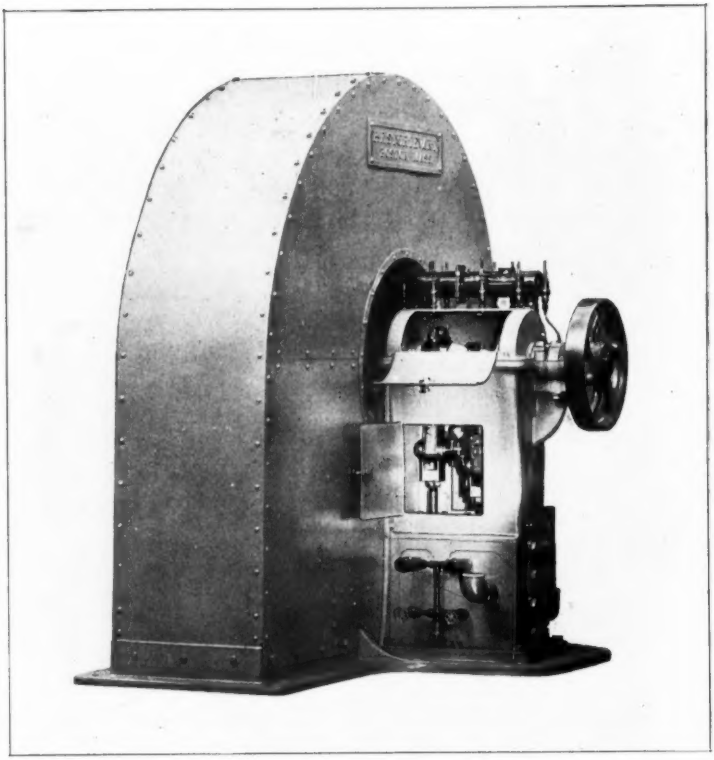
tric auxiliary machinery on shipboard can be answered only after a consideration of all the points involved.

The auxiliary machinery on a battleship includes: air, circulating, feed, and bilge pumps; ventilating and forced-draft blowers; anchor and steering engines; ash hoists, ice machine, turret engines, ammunition hoists, dynamo engines, machine-shop engine, winches, boat hoists, air compressors for charging torpedoes, etc. In short, there is



ADMIRALTY SURFACE CONDENSER, COMBINED WITH AIR AND CIRCULATING PUMP.
A form of condenser generally adopted on war-ships when the direct-connected air pump is not used. Made by Wheeler Condenser & Engineering Co.

the formidable array of about forty auxiliary engines on a modern battleship, scattered from one end of the ship to the other and in some cases requiring long pipes if operated by steam. These engines are from 2 to 100 h. p. each. The maximum horse power of all is about 1,500. Each machine is usually operated at not more than one-half full power and the maximum power of all the auxiliary machinery in operation at one time, which is in battle, is only about 700 h. p. This



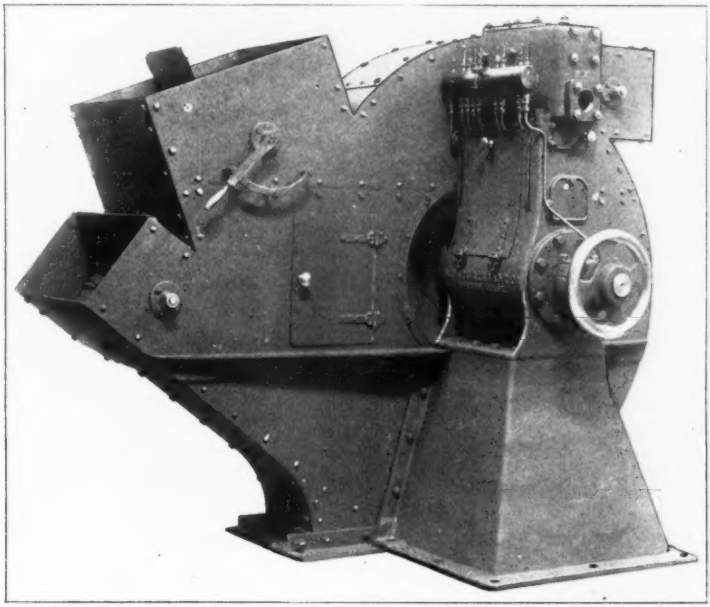
FORCED-DRAFT STEAM FAN, FOR MARINE INSTALLATION.
Made by the B. F Sturtevant Co.

machinery is nearly all of it such as requires a large torque at its highest speed.

The principal advantages following the use of electricity for the operation of all the auxiliary machinery, aside from economy (which will be discussed later), would be those due to the elimination of the long lines of steam piping now necessary. These are not inconsiderable gains. The long pipes to the anchor and steering engines offer, in time of battle, elements of danger which the use of electric wires would avoid. The steam piping has gaskets to blow out, and besides it makes holes in water-tight bulkheads that can only be kept from vitiating the water-tight subdivision of the ship by great care. The

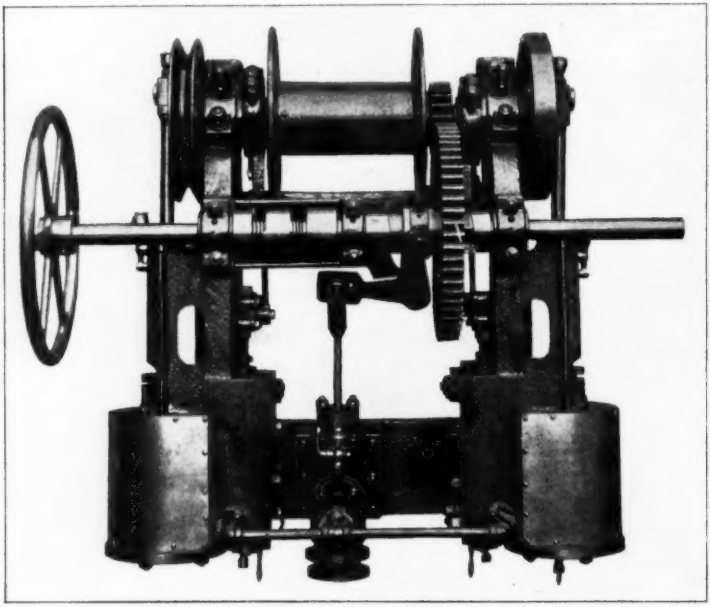
steam pipes heat the ship in the crowded under-water compartments which are hot enough at best. Other advantages of electrically-operated auxiliaries are cleanliness and ease of operation and control. Of course, to attain this ease of operation in a case where electricity is widely used, the generator must have a considerable range of power beyond that ordinarily used; otherwise the starting of an auxiliary engine might involve burning out an armature, and certainly would involve the delay necessary to start up another generating set.

Against these, the great advantage of steam-operated machinery is its security. The introduction of an extra transformer of power, between the boiler and the engine, causes a complication that must always settle the question for such auxiliaries as those necessary to the operation of the main engines—the air, circulating, and feed pumps. Other advantages claimed for steam auxiliaries are that they are simpler, less bulky and, generally speaking, that their repair is easy on board ship and that any defect can readily be found. If overloaded, a steam engine will simply stop. There is no danger of a burnt arma-



STEAM-DRIVEN MARINE VENTILATING FAN, WITH ADJUSTABLE INLETS AND OUTLETS.

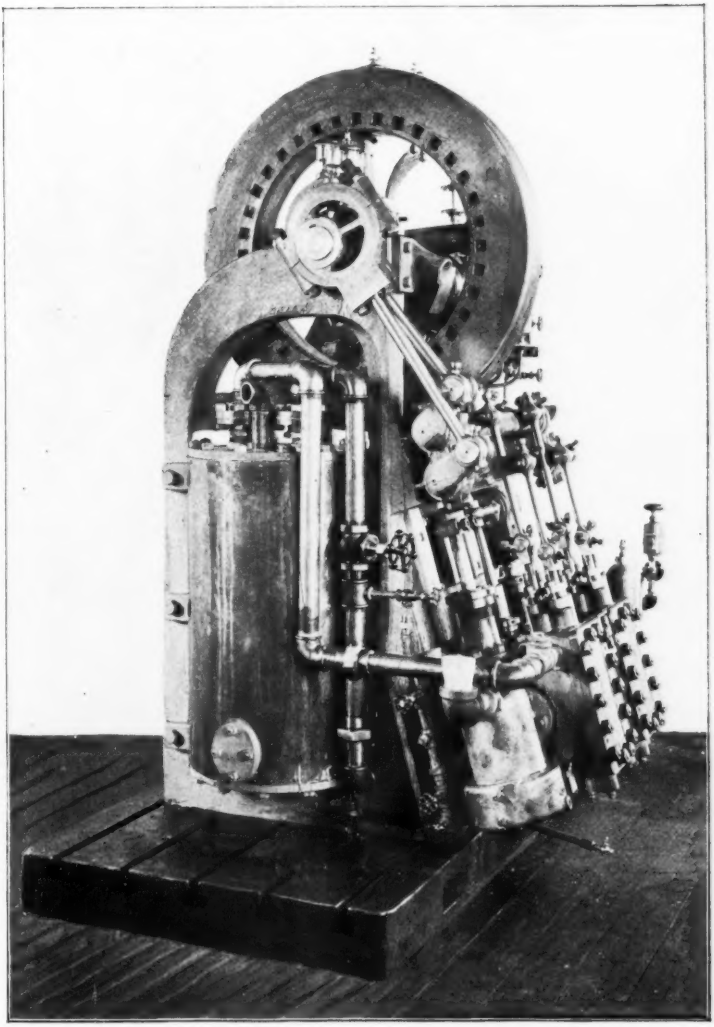
ture, nor even of a blown fuse. It is also asserted, as a disadvantage attendant upon the use of electricity in place of steam, that the motors must be of considerably higher rated horse power if electrically operated than is necessary with steam engines. This every large user of electric motors has already found for himself. In order to obtain the requisite torque at the highest speeds, coupled with delicacy of control at low speeds, electric motors must be of about 50 per cent. greater power than steam engines for the same work.



STEAM ASH-HOIST. IN USE IN UNITED STATES NAVY.

The engine is reversible, and is operated by the hand wheel. It runs as long as the wheel is revolved, and stops automatically when the wheel is stopped.
Made by Williamson Bros.

The foregoing advantages and disadvantages are really minor ones. Summed up, they mean that steam must be used for auxiliaries directly connected with the main engines, but that it would be more convenient to operate other auxiliaries by electricity if proper motors can be furnished. This leaves the question open as to the major part of the auxiliary machinery on board ship, and this question must be

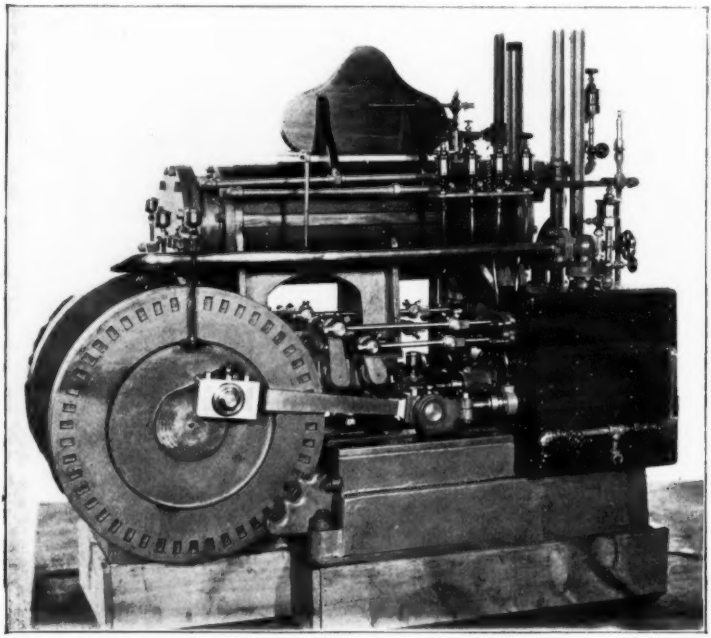


ALLEN VERTICAL DENSE-AIR ICE MACHINE. ONE-TON CAPACITY.
Installed on Austrian cruiser Zenta.

considered on broad grounds and decided in favor of that system which best serves the efficiency of the ship as a fighting vessel.

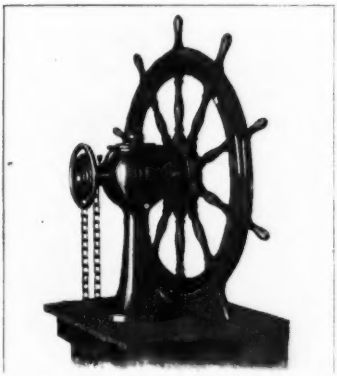
Mahan has pointed out that the value of any fleet depends upon: first, its offensive power; second, the period during which it can maintain an offensive position; and, third, its dirigibility. In other words, the power of a fleet to injure an enemy may be taken as the product of its gun power, its coal endurance, and its speed. A change from steam to electricity must be made only if it affects favorably one of these three vital elements of war-ship design.

Experience with the electrically-operated turret machinery on the



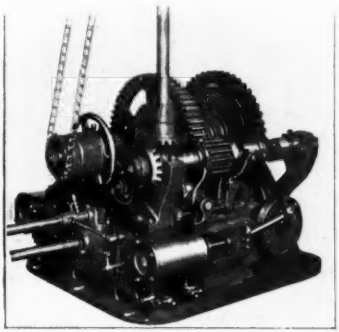
ALLEN HORIZONTAL DENSE-AIR ICE MACHINE.
Type especially adapted for marine installation.

Brooklyn and Massachusetts has shown it to be more delicate in its action than was the steam turret machinery on those ships. This is a matter involving the efficiency of the guns, and the use of electrically-operated machinery for the turrets probably secures a direct addition to the gun power of the ships; for this purpose, therefore, electricity should be adopted. The same good results have been obtained from electrically-operated ammunition hoists, and here, too,



electricity should be used. Of course, electricity is a necessity for the search-lights and for the lighting of the ship. For most of the auxiliaries, however, the question rests upon the economy of the machinery, whether operated by steam or electricity.

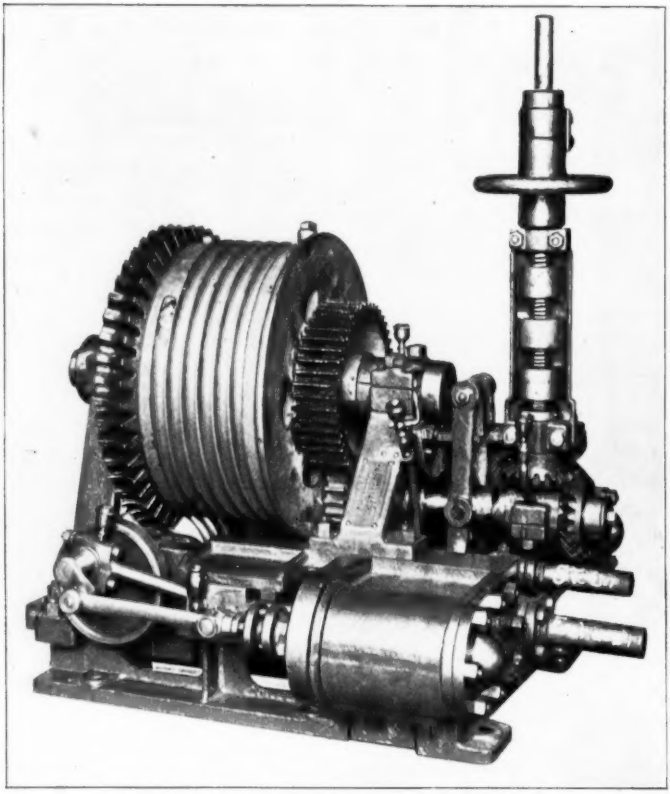
There are two ways of increasing the radius of action of a ship—first, the obvious one, by increasing the bunker capacity; and second, the indirect method of obtaining the same result, by increasing the potential value of each pound of coal through an increase in the economy of the use of steam. The first method is the natural one and the universality of the study to increase bunker capacity is immediately apparent upon comparison of the naval designs of to-day with those of a decade ago. It is worthy of note, however, that an addition to the bunker capacity of a ship is not all net gain. Increase in bunker supply implies an increase in the size of the ship, an increase in the size of the target, in the weight of the hull and armor, and in the weight of the machinery for giving this larger ship the same speed which a smaller one might have. It also involves increase in the weight of coal necessary to drive the ship at this given speed. On the other hand, any increase in the economy of using the coal, or, what amounts to the same thing, any increase in the economy of steam consumption, increases directly the steaming radius of the ship and is a positive gain. Of course, the addition of any device to avoid waste is bound to increase more or less the weight of the machinery of the ship. But if the economy secured is greater



STEAM AND HAND STEERING ENGINE.

The engine is actuated from the hand wheel above, which may be on any deck. The change from steam to hand steering is made by turning the small wheel on the left in the upper engraving Made by Williamson Bros.

than the weight added, the installation of the device is advantageous. Thus, if increase in the cylinder ratios in naval vessels should be followed by a decrease in coal consumption of, let us say, six per cent.,

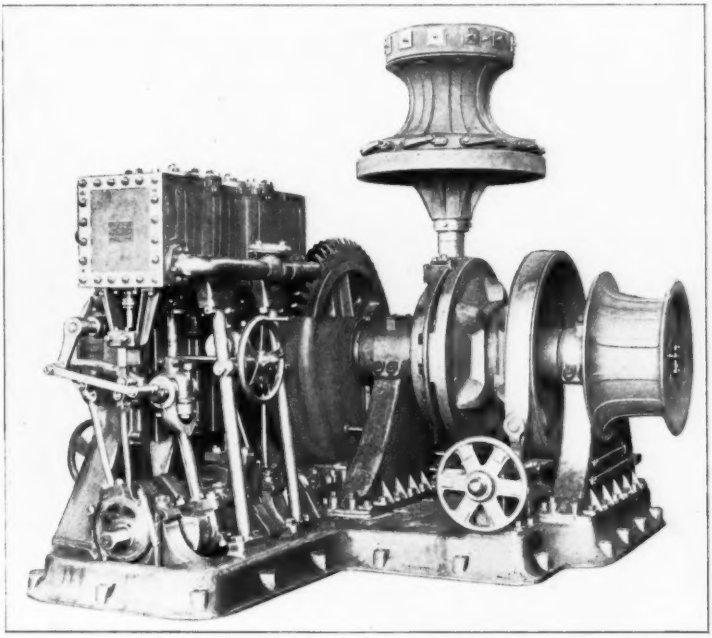


AUTOMATIC WORM-GEARED STEAM STEERING ENGINE.
The engine follows, automatically, the motion of the hand wheel. It is fitted with stops to regulate the "hard-over" movement, to prevent the engine pulling against the rudder stops. Made by Williamson Bros

accomplished with an addition of but ten tons to the weight of machinery, it would be advantageous to make this change if ten tons were less than about six per cent. of the bunker capacity of the ship.

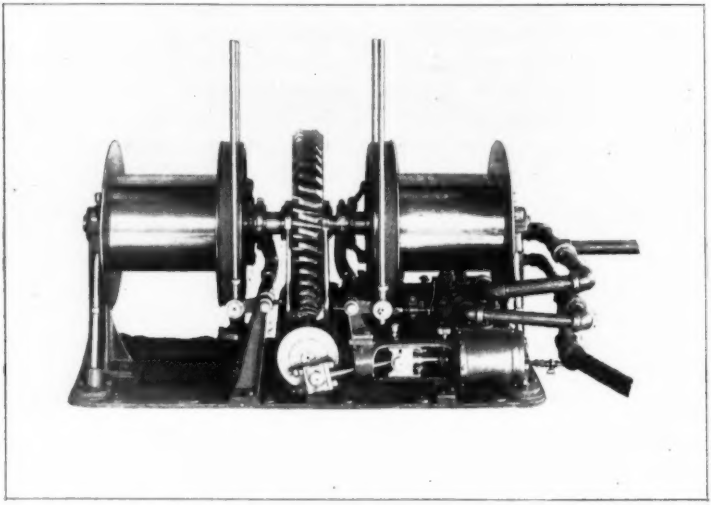
For example, take a ship with a bunker capacity of 500 tons and with a steaming radius of, say, 8 sea-miles per ton of coal, or 4,000 miles. If the addition of 10 tons to the machinery weights increases the

economy 6 per cent., we would then be able to make 8.48 miles per ton of coal with 490 tons in the bunkers, or the steaming radius would be increased to 4,155 miles. On the other hand, take the case of a torpedo boat in which it might take the addition of 5 tons to the weight of the machinery to secure a saving of 6 per cent. in the steam consumption, and in which the bunker capacity was, in the first place, but 35 tons. This ship would probably have a steaming radius of 40 sea-miles per ton of coal, or 1,400 miles in all. In this case, the weight added to the machinery would involve an increase from 40 to 42.4 in the number of miles the boat would be able to make per ton of coal, but there would be but 30 tons of coal in the bunkers and the steaming radius would be reduced from 1,400 miles to 1,272.



STEAM WINDLASS FOR 2½-INCH CHAINS.
Installed on U. S. battle-ships Alabama, Wisconsin, etc., by Hyde Windlass Co.

It may be said that the 5 tons could simply have been added to the displacement of the torpedo boat, but even then there would be nearly the same proportional gain in coal consumption if the added



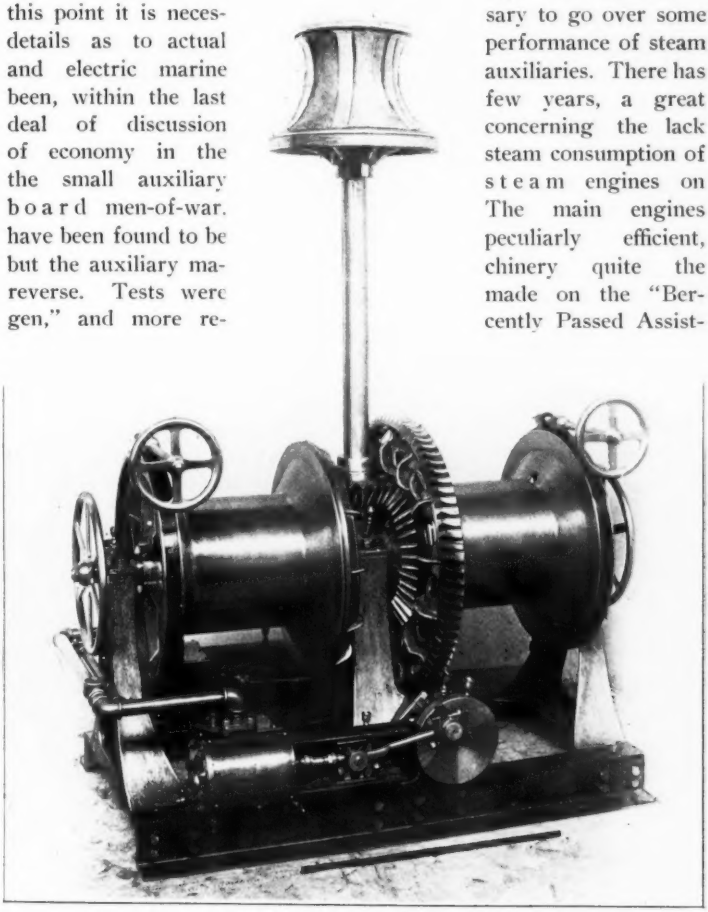
STEAM WINDLASS FOR ¾ INCH WIRE ROPE.

Driven by double non-reversing 4 x 4 engines, and controlled from below or from upper deck. Will take in 12 fathoms cable per minute at 400 revolutions. Built for U. S. torpedo boat Bailey by American Ship Windlass Co.

weight were put on board in the form of coal, and not in that of the apparently economical addition to the mechanical weights. Some of the most obvious apparent economies often involve a real loss—in coal endurance as well as in business.

American designs of war vessels have always been noted for their predominance in gun power, and more than once have American vessels established a record for speed; but I fear that in American naval designs, up to within a very few years, sufficient strength has not been laid upon the vital point of coal endurance—or, in other words, the distance a ship can go without replenishing her bunkers. Sir John Durston, engineer-in-chief of the British navy, states that this is the most important of all the present problems of naval design. While we may or may not agree that the coal-endurance question is to-day paramount, such a statement as the foregoing, coming from an official source of so high authority, demands close attention. At any rate, the particular question as to the extended use of electrically-operated auxiliary machinery must be decided upon the broad ground of economy. Considered from standpoints purely technical and tactical, it will pay us to use electric auxiliaries under the following conditions only:

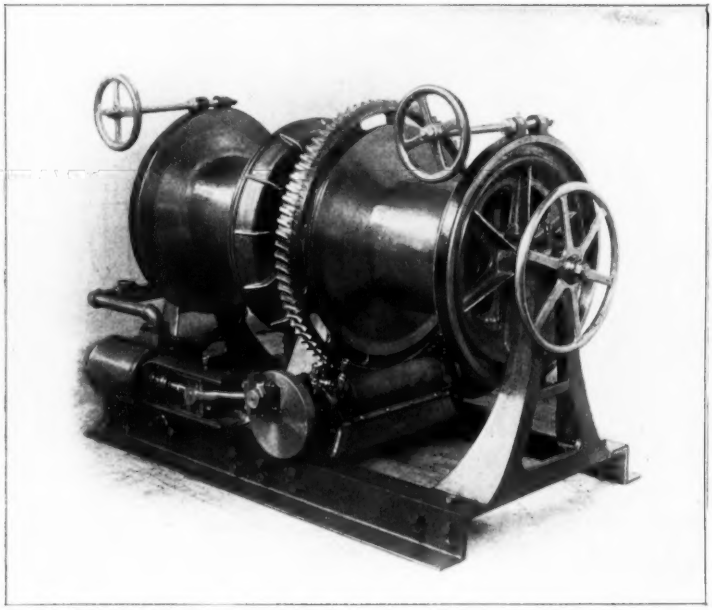
First, electric auxiliaries must be more economical than the steam auxiliaries they replace; second, the difference between the weight of the electric and steam apparatus must not exceed, in percentage of the coal-carrying capacity, the economy incident to the use of electrically-operated machinery. To understand this point it is necessary to go over some details as to actual performance of steam and electric marine auxiliaries. There has been, within the last few years, a great deal of discussion concerning the lack of economy in the steam consumption of the small auxiliary engines on board men-of-war. The main engines have been found to be peculiarly efficient, but the auxiliary machinery quite the reverse. Tests were made on the "Bergen," and more recently Passed Assist-



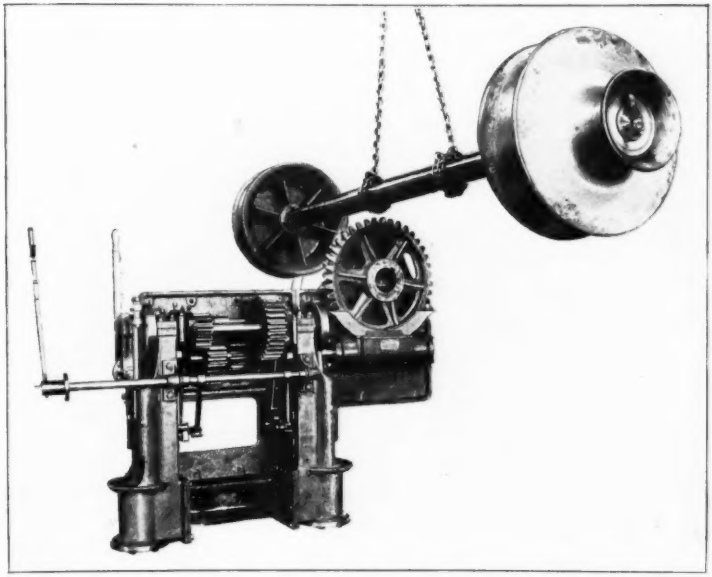
STEAM WINDLASS FOR TORPEDO BOAT, WITH 4 x 4 DOUBLE ENGINE.

Installed on U. S. torpedo boat Stringham. Weight, 1 593 lbs. Stows 60 fathoms ⅞ in. wire cable on each drum. Lifted 2,250 lbs. with 60 lbs. steam.
Made by Hyde Windlass Co.

ant Engineer W. W. White, of the United States navy, has thoroughly developed the lack of economy of the small steam auxiliaries. Mr. White made an extensive series of tests of the steam consumption of all the various engines of the Minneapolis and he discovered a condition of affairs that was startling. There is no use in giving all his results here. It is sufficient to say that the average steam consumption per i. h. p. per hour of the auxiliary machinery of the Minneapolis was found to be 119 pounds. This result was obtained with machinery operating under the average service conditions, with speeds and powers varying at different times. The consumption of the better class of the auxiliary steam engines, and of those which were worked frequently to their full capacity, was found to be approximately 52 to 75 pounds per hour, the consumption of some of the pumps being considerably less than 100 pounds per hour. For some of the slow-moving, direct-acting steam pumps, operated, as they not infrequently are, with a choked exhaust to ensure smooth



STEAM-DRIVEN TORPEDO-BOAT WINDLASS FOR ¾-INCH WIRE CABLE.
Installed on United States torpedo boats Foote, Rodgers, and Winslow class. Made by Hyde Windlass Co.



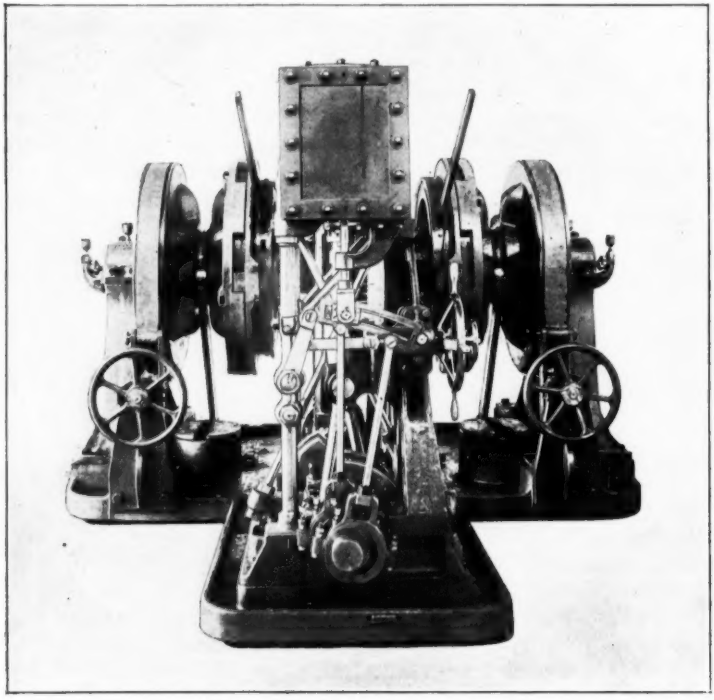
AUXILIARY STEAM WINCHES WITH 8 x 8 ENGINES.
Installed on United States battle-ships Kearsarge and Kentucky. Made by American Ship Windlass Co.

operation, the steam consumption was found to be more than 300 pounds. With ordinary auxiliaries in operation, with the ship cruising at about 10-knots speed and with the main engines developing about one-twelfth their maximum power, the steam consumption of the auxiliary machinery was found to be about 23 per cent. of the total amount of steam used.

The publication of the results of the experiments made on the Minneapolis was, perhaps as much as anything else, the cause of the great variety of investigation and progress on the subject of auxiliary machinery that has taken place within the last two years. Trials of the British cruiser Arrogant showed a steam consumption by the auxiliary engines, when the ship was working at low powers, of about 35 per cent. of the total steam consumption. Similar bad results were obtained on the Powerful. Recent experiments on some English ships indicated that the steam consumption of the auxiliary machinery was about 22 per cent. of the total when the engines were working at one-fifth power, the relative auxiliary consumption decreasing as the

power increased, to about 10.4 per cent. of the total at three-fourths power. These results were obtained on the Argonaut. Somewhat better results are stated to have been obtained on the Vindictive.

The United States Navy Department, instead of merely securing the best auxiliary machinery in the market, has made demands for unusual economy-performance of the steam auxiliaries. The



STEAM WINDLASS FOR 2½ INCH CHAINS.

Double engines, marine type, 15 x 14. The friction bands are strong enough to ride by. Weight, including chain stoppers, about 30,000 lbs. Installed on United States battle-ships Kearsarge and Kentucky. Made by American Ship Windlass Co.

manufacturers of small engines, and particularly the manufacturers of steam pumps, have devoted their attentions within the last few years to the production of economical auxiliary machinery. Recent tests made by officers of the United States navy show that with compound pumps, now so widely used, the steam consumption has been cut down to a point considerably below 80 pounds

per effective horse power per hour. Manufacturers of the best types of small steam engines for driving centrifugal pumps, fans, etc., have considerably improved the economy of these engines, cutting down the steam consumption to about 50 or 60 pounds per i. h. p. per hour. The evaporating plants of ships are now often arranged to work as double- and triple-effect plants. The only objection to this system appears to be the increased space required. This system has already been fully discussed in THE ENGINEERING MAGAZINE, and it is sufficient to state that, with the new methods of operation, the steam consumption of the evaporating plants has been reduced at least 30 per cent. In short, we may take it that within the last five years the average steam consumption of such auxiliary engines as are now installed on men-of-war has been reduced from 120 pounds per i. h. p. per hour to 65 or 70 pounds per i. h .p. per hour.

All of the foregoing investigation, or at least nearly all of it, was caused by a desire to increase the efficiency of the auxiliary machinery of ships as steam users. Many general changes have been made in design with the same end in view. The exhaust from the auxiliary machinery has not infrequently been arranged to run into a feed heater where the latent heat is entirely abstracted from the exhaust steam and used in raising the temperature of the feed water to about 210° F. This practice is to-day almost universal. It is frequently, and indeed generally, found that the amount of steam used by the auxiliary machinery, when the main engines are operated at as much as one-fifth full power, is not in excess of that required to heat all the feed water to the figure above quoted. Consideration should be given, however, to the fact that, in many cases, the power developed by the main engines is considerably less than one-fifth their maximum power, and in these instances it is not infrequently the case that the feed water will not condense all the exhaust steam from the auxiliary system at atmospheric pressure. Connections between the auxiliary exhaust pipe and a low-pressure evaporating plant (the second effect of a double-effect evaporator) have been made in many ships, the object being to care for any surplus exhaust steam that could not be condensed in the feed heater.

Probably the introduction of the auxiliary feed heater is the greatest step towards economy that has been made of late years in marine engineering. As at present arranged, steam is taken from the boiler to operate the auxiliaries and the exhaust is condensed in heating the feed water, the condensed exhaust steam being generally returned to the boiler by the feed pumps. This involves the conversion of the

auxiliary machinery into theoretically-perfect engines. Their efficiency (radiation, friction, etc., not being considered for the moment), is practically unity. Every thermal unit abstracted from the boiler is converted either into useful work done in the auxiliary machinery or into useful work done in heating the feed water. The economy due to the use of the auxiliary feed heater is something like 8.9 per cent., as can readily be seen from the following:

Without the auxiliary heater the temperature of feed was ordinarily about 100° F. to 120° F.—say, as an average, 110° F. A series of tests at sea on the Minneapolis showed the average temperature of the feed water on that ship to be about 85° F. With the auxiliary feed heater in use, the temperature of the feed has been raised to 200° F. or 220° F. Some experiments show a temperature of feed as high as 234° F. It is not generally considered advisable, however, to pass 212° F., the temperature of evaporation of water at atmospheric pressure. Generally speaking, it may be said that the temperature of the feed water with the auxiliary feed heater in use, as now generally provided for in all marine designs, will be about 210° F. For the production of saturated steam at a pressure of 200 pounds from a temperature of 110°, 1,120 B. T. U.'s are required. If the temperature of the feed be increased to 210° the number of B. T. U.'s required for the generation of one pound of saturated steam at a pressure of 200 pounds is reduced to 1,020. The ratio between these two figures, 1,020 and 1,120—91.1 : 100—represents the ratio between the coal burned with and without the auxiliary feed heater in use. This is almost absolutely true, inasmuch as the steam consumption of the auxiliary engines is not appreciably increased by the raising of the back pressure from 4 pounds to 15 pounds absolute.

The foregoing is probably the best solution that steam engineers have given this problem. Other suggestions have been made, however, which are decidedly good as far as they go. For example, in many cases provision has been made for leading the exhaust from the auxiliary machinery into the low-pressure receivers of the triple-expansion engines generally fitted in naval vessels. In one case (the Olympia) an experiment with this adjunct in use showed a saving in coal burned of about 4 per cent. In other cases the result has not been so satisfactory, on account of failure efficiently to remove the entrained water from the exhaust steam of the auxiliary machinery. Some English engineers have proposed to work the auxiliaries in series, operating some of them by the exhaust from others, and finally turning the exhaust of the second set of auxiliaries into the evapora-

tors. It practically converts the auxiliary machinery into triple-expansion engines. Other engineers, noting the gross waste due to the use of steam at 250-pounds pressure in the auxiliaries, have proposed to fit a reducing valve on the auxiliary steam pipe operating all the small engines with a pressure not to exceed 160 pounds.

With the progress that has thus far been made in the design of auxiliary machinery, the average steam consumption of the auxiliaries has been brought below 70 pounds per i. h. p. per hour, as has already been said. Recent tests show that the steam consumption of the increased large number of auxiliaries fitted in naval vessels is from 10 to 20 per cent. of the total steam consumption, according to the speed of the ship. With a feed-water heater installed, it is properly maintained that, as long as the auxiliaries use no more steam than can be directly condensed in this heater, it makes no difference how much steam the auxiliaries use, inasmuch as every heat unit is usefully abstracted from every pound of steam passing through the auxiliary system. It is further asserted that any excess of steam used by the auxiliary system, above that required in the feed-water heater, can be very economically utilized in the evaporating plant. This use of the auxiliary exhaust steam offers disadvantages, on account of the complexity of the piping, and particularly on account of the necessity of maintaining two pressures in the auxiliary exhaust system. It has been found impossible to obtain satisfactory results from the evaporating plant if the steam pressure is below 25 pounds. The use of the auxiliary exhaust in the evaporating plant, therefore, necessitates fitting delicate differential reducing valves in the exhaust system. These difficulties have been satisfactorily overcome in several English men-of-war, with a most satisfactory resulting increase in the economy, amounting in one case to .15 of a pound of coal per hour for each horse power of the main engines.

The theoretical proportion of the total amount of steam used, condensible in a feed-water heater which shall raise the temperature of the feed water 100°, may be shown to be something less than 10 per cent. When the losses due to radiation are taken into account, as well as the loss due to condensation of steam in the auxiliary engines and steam piping, it is found that as much as 12 per cent. of the tota steam consumption can, after passing through the auxiliary system, be condensed in an auxiliary feed heater. Of course, where the initial temperature of the feed water is very low, this proportion can be increased; but, as a general thing, it may be stated that the amount of steam that can be allowed to pass through the auxiliary system must

not exceed 12 per cent. if it is all to be condensed in a feed heater which shall not raise the temperature of the feed water above 212°. Tests have shown that the amount of steam required by the evaporating plant of a ship varies from 1 per cent. to 8 per cent. of the total steam consumption. It averages about 3½ per cent. of the total steam consumption when the vessel is cruising at reduced speed. With the evaporators now generally provided for in naval design, it is found to require about 40 per cent. more steam in the evaporating plant for the same output of the exhaust steam from the auxiliaries is used instead of live steam from the boilers. Steam from the auxiliary system can, therefore, be used advantageously in the evaporating plant up to about 5 per cent. of the total steam consumption. Neglecting the possibilities of a connection between the auxiliary exhaust system and the receiver of the main engine, we have, as the maximum amount of steam which should be used in the auxiliary system, about 17 per cent. of the total, 12 per cent. being accounted for in the feed heater and 5 per cent. in the evaporating plant. If the steam consumption of the auxiliaries exceeds this amount it is a direct loss. If, on the contrary, it is less than this amount, unless the saving be accompanied by a reduction in the condensation throughout the auxiliary system, there will be practically no gain.

As has already been said, the steam consumption of auxiliary machinery, as at present fitted on naval vessels of the latest type, rises to about 20 per cent. of the total at the lowest speeds. For the speeds and powers prevailing in time of war the figures should probably be taken at somewhat lower than 20 per cent.—say about 18 per cent. The designers of steam auxiliaries have, therefore, brought the steam consumption sufficiently low to reduce the waste under the most trying conditions to 3 per cent. and this waste in time of war will probably never exceed 1 per cent. The complex fittings required to enable the turning of the auxiliary exhaust into the evaporating plant, as well as the increased amount of steam required to operate the evaporators under these conditions, would make it advantageous to reduce the auxiliary consumption of steam to such a figure as would allow of its all being condensed in the auxiliary feed heater. There is room, therefore, for considerable further improvement in the design of auxiliary machinery. In the next number of THE ENGINEERING MAGAZINE I shall consider the promise afforded by the adaptation of electric operation to marine auxiliaries, and the limitations which seem to affect the adaptation, on shipboard, of the central-station practice which has given results so good on shore.

EDITORIAL COMMENT

THE work of the International Association for Testing Materials, which forms the subject of a review elsewhere in these pages, was recently set forth in THE ENGINEERING MAGAZINE in leading articles by Mr. W. R. Webster and Mr. Gus. Henning. It is gratifying to see that both the increase in the membership of the Association and the increase of recognition of its work by the industrial press bear witness to the growing appreciation of its value to the engineering world. The radius of engineering trade is continually lengthening; the farther it extends, the more emphatic is the need for a basis of absolute understanding between bidder and receiver of bids—between buyer and seller. "The foundation of knowledge is laid in definitions," and the association is working toward an international agreement upon the definitions which are essential to a mutual understanding between purchaser and maker. The mere introduction of physical tests was an enormous advance step toward security. Their unification as to method is the necessary complement. When the builder of an engineering structure, or the purveyor of engineering materials, knows exactly how the consignee's requirements are to be interpreted; when the purchaser knows exactly how the furnisher's guarantee is to be construed—an era of mutual confidence will be established which will be enormously conducive to industrial security and engineering expansion.

WHEN Solomon was building the temple, he called upon Hiram of Tyre for the hewing and fashioning of cedar wood, for the cutting and moving of "hewed stones to lay the foundations of the house," and for cast work and wrought work in brass. In other words, Hiram was directing a general engineering business, and, under the conditions of the time, it was doubtless a wise policy.

In the three thousand years since elapsed, the wood, stone, and metal trades have become fairly well differentiated; but many British engineering works are to-day undertaking a business almost as diversified as that of the old Sidonian. But the signs of change are apparent everywhere, and in this issue three great exponents of advanced thought and practice—Sir Benjamin Browne, Mr. J. Slater Lewis, and Mr. Henry Roland—begin, each from a different viewpoint, three strong expositions of the new order of specialisation and standardisation.

This movement, in which the United States is far more advanced than the Old World, promises, indeed, to be one of the greatest of the century—and that is saying a good deal in a century which saw the birth of steam and electricity and the general introduction of machinery. It is greatest because it provides the method by which to use most effectively and economically the new forces and their media of application. The world is increasingly intolerant of waste, either

of material or energy. Diffusion of study and attention, duplication of plan and plant, the compromise of the ability to do something well for the ability to do many things indifferently —all these are waste of the most flagrant and irretrievable kind—waste of productive power which, unused to its full, is lost forever. Society, as it grows more complex, tends increasingly to larger community of interest and minuter differentiation of individual function. The order of evolution is the same for the mechanical industries, and the gradual dissolving of national limits in industrial competition is one of the most potent agencies in working out the process.

* * *

Specialisation has three great beneficial results—it quickens production, cheapens production, and raises the quality of the product. Of these the third is, of course, essentially the greatest. The world is learning daily to be more and more critical of engineering manufactures, and only the best can long survive. But temporarily it seems as if quickened production were almost the most important end for which to strive. Many of the recent purchases of American locomotives for British and European installations have been determined by possibility of quick delivery. In the lately-reported case of the ordering of Baldwin locomotives for the Saxon railways, the contract is said to have been given to the American firm at a slightly higher figure than that asked by home builders, solely because the engines could be supplied more quickly from Philadelphia than they could from any of the German works.

There is no possibility that return will be made to the leisurely methods of working which are so closely associated with the policy of generalised engineering manufacture. The new countries, which are being suddenly awakened and hurried forward in at least the material phase of civilisation —the precipitated demand of nations more numerous than the whole white race, and with the accumulated needs of centuries of stagnation to be made good—these are going to tax the productive capacity of the whole industrial world, and every method and every institution which interferes with the realisations of the ultimate possibility of output must be discarded, or will be swept away. Intensified production is the motto of the times. Capital seems to appreciate the situation more clearly than labour. And the next great problem to solve relates to the care of the worker. It is foreshadowed in McAndrew's Hymn:

* * * "What I ha' seen, since ocean-steam began,
Leaves me no doot for the machine: but what about the man?"

As Mr. Orcutt put it, in concluding his papers in the August number of THE ENGINEERING MAGAZINE: "How to mitigate the incapacitating effects of routine work is one of the coming industrial problems." It may work itself out with as great a reversal of anticipatory fears as did the introduction of labour-saving machinery. But it is deserving of the most earnest thought of the best thinkers. Sir Benjamin Browne's third paper, in THE ENGINEERING MAGAZINE for December, will be devoted to this phase of the question.

REVIEW OF THE BRITISH PRESS

The Liverpool Motor Trials.

WHILE it appears to be generally conceded that France has made the greater progress in light motor vehicles, especially for personal and pleasure use, the tendency in England has rather been toward the design of less ornamental but probably more useful machines for carrying merchandise.

The recent trials of motor vehicles held at Liverpool under the auspices of the Liverpool Self-Propelled Traffic Association, of which accounts are given in both *Engineering* and *The Engineer,* furnish some interesting data as to the construction and performance of heavy motor vehicles for carrying goods.

The trials of last year demonstrated two facts which had material influence upon the competitions which have just been held. In the first place the poor quality of the roads showed the necessity for much stronger wheel construction than had been thought necessary, and in the second place the availability of steam motors for such work was clearly shown.

This year the only motors exhibited were steam engines, and with high-pressure boilers and air condensers ample power appeared to be attainable.

The chief object of the trials was to encourage the development of types of heavy motor wagons suitable for the trade and agricultural requirements in the neighbourhood of Liverpool, capable of economically taking the place of horse haulage and of competing with the existing railway rates in the transport of heavy loads of goods over distances of forty miles. The distances between the stations provided for the supply of water did not exceed twelve miles in any case, and the roads offered grades ranging from 1 in 22 to 1 in 9, with surfacing of various kinds.

But six vehicles appeared for the trials, and these are fully described in the journals referred to. As evidence of the experience of the previous year a few details may here be mentioned. The vehicle of the Steam Carriage and Wagon Company (Thorneycroft) was provided with wheels intended to overcome the weakness formerly developed. Instead of iron wheels driven by chain gearing, heavy wooden wheels are now used, but these are not driven directly from the hub, but by means of plate springs fixed to the axle and connecting with the wheel rims. This method not only avoids shock in starting, but also removes the twisting action on the spokes which occurs when the driving is applied at the hub. Two machines of this kind were exhibited, the boilers being of the Thorneycroft type, for use with oil fuel, and the compound engines being enclosed and connecting with the wheels by spiral spur gearing.

The other vehicles did not show such material differences from those exhibited last year, but that the re-design was an improvement is evident by the superior manner in which the Thorneycroft vehicle performed.

The trials demonstrated very clearly the practicability of such vehicles for regular service so far as manipulation and carrying capacity are concerned, while the crucial test of commercial economy can only be determined by prolonged usage. The hill-climbing tests showed that there was ample power in the machinery and that adhesion to the road bed was the essential matter, since the hills were climbed more successfully by the vehicles when loaded than when running empty.

The significance of these trials may not appear at once, but there can be little doubt that they and other such experiments are forerunners of the general application of mechanically propelled vehicles for general uses of all kinds. The whole subject of hauling on common roads is far behind the rest of modern industrial methods and now that energetic attention is being directed to the subject there is every reason to believe that there will be no relaxation until success has been mechanically and commercially attained. The question of road

construction will have to receive the same attention that is now given to permanent way for railways, and under the open competition which exists in design and construction of vehicles there is every reason to expect rapid and practical advance.

Progress in Space Telegraphy.

It is generally understood that the vital feature in telegraphy across space without the use of conducting wires lies in the action of the coherer, and hence anything which adds to the sensitiveness or efficiency of this portion of the apparatus is of especial interest. In the apparatus as heretofore used it has been necessary to provide for the restoration of the particles in the tube of the coherer by tapping after each impulse, and this has led to a complication of the apparatus and has limited the speed of transmission to about ten words per minute on the Morse code.

A paper recently presented to the Royal Society by Professor Chunder Bose gives details of some interesting and important experiments made by him upon coherers of various metallic substances, which go to demonstrate that rapid and automatic decohering is entirely practicable. The paper is published in full in the *Electrician*, together with editorial comments expatiating on the importance of these investigations, and an abstract of both is here given.

The ultimate object of these researches was to determine, if possible, the correlation between the chemical associations of the materials used in coherers and that particular physical property, or group of properties, by virtue of which coherence takes place. For this purpose a systematic study of the properties of various metals and combinations was made, and while the result has not settled any definite or exact relation between composition and cohering action a number of important and valuable practical facts have been brought out.

The use of iron or steel in damp climates gives troubles from oxidising, and a consequent reduction in sensitiveness, and to overcome this difficulty experiments were made by coating steel spirals with deposits of various metals, and subsequently fine silver threads were employed instead of the steel spirals. The silver threads were coated with cobalt in an electrolytic bath, this surface being found very sensitive to electric radiation and not liable to such chemical changes as occur in the case of steel.

Dr. Chunder Bose describes in detail the apparatus by which he was enabled to make experiments with various metals under closely graduated degrees of pressure, and then proceeds to examine the behaviour of the different substances to be tested. He at once found differences under different conditions, the pressure and the e. m. f. of the current also exercising marked influence upon the electrical resistance. The especial fact of importance which appeared was that with some materials the action of the electric waves increased the resistance instead of decreasing it.

With the ordinary coherer it has been assumed that the passing of an electric wave caused the particles to unite, or cohere, thus diminishing the resistance and permitting the passage of the current to the receiving instrument. These experiments show that the action of the waves is to vary the resistance, but that with some materials, notably with the metals of the alkali group, the resistance is increased. When potassium was used, the first experiments appeared to show no response to radiation, the galvanometer needle remaining immovable, but, thinking that this might be due to response followed by immediate recovery, a telephone was substituted for the galvanometer, and the truth of the supposition was demonstrated.

This at once suggested the possibility of using potassium to make an automatic coherer, but it was found that this power of self-recovery ceased after twenty or thirty flashes, although it could then be restored by tapping. When the coherer is immersed in kerosene the power of self-recovery is not lost, and some construction of this sort may become of much practical value.

"Given a coherer that will always promptly de-cohere on the cessation of the Hertzian impulse, many achievements would be possible in wireless signaling which are now quite impracticable. Wireless telephony would be easily attained; though, by the way, the possessors of wireless telephones would have to be restricted to one happy couple within each area of influence. In bygone days steam engines were worked by the aid of little boys sta-

tioned at the valves. The lads worked perfunctorily; but the service was good enough for the engines, which were never expected to go beyond a very slow speed. Had automatic valves not been invented, high-speed engines would have been an impossibility. The coherer practice of to-day resembles the steam-engine practice of the days when the boys worked the valves. Wireless signals can only be sent with that painful slowness—say, ten words per minute on the Morse code—which is the limit of the performance of a coherer depending upon the attentions of a mechanical tapper. When the coherer has been invented that will automatically and promptly de-cohere, wireless signalling will make just that same advance upon its present condition that the steam engine made when automatic valves came into use. Dr. Bose's researches furnish one more step, and an important step towards that goal."

The Arrangement of Marine Boilers.

In view of the interest which has been shown in the subject of water-tube boilers, and of the conflicting experiences of various countries and vessels in connection with the steam-generating portion of naval equipment, the paper of Mr. F. T. Marshall before the Institution of Naval Architects upon the boiler arrangements of certain recent cruisers is especially timely. Although the paper refers particularly to the boiler arrangement of but a few vessels it is of especial value, since in these vessels are included, beside the ordinary cylindrical fire-tube boiler, both varieties of water-tube boiler, the large-tube system being represented by the Belleville boiler and the small-tube design by the Yarrow boiler.

The vessels especially under consideration are H. M. S. Andromeda, built at the dockyard at Pembroke, and the Portuguese cruiser Dom Carlos I., built at Elswick, and the Chinese cruisers Hai Tien and Hai Chi, also built by the Armstrong Company. To these have been added data about H. M. S. Heimes, and H. M. SS. Aeolus and Pallas, which are typical second and third-class cruisers with cylindrical boilers. Of these vessels the Andromeda and the Hermes are fitted with Belleville boilers, the Chinese boats and Aeolus and Pallas have cylindrical boilers, and the Dom Carlos I. Yarrow boilers.

The Belleville boiler, which is of especial interest at the present time, is an excellent example of the so-called "large-tube" variety; and when arranged, as in the case of the two vessels above named, with economisers, the performance, so far as fuel economy is concerned, is all that could be desired. The general construction of the Belleville boiler is sufficiently well-known to need no detailed account here, and in the case of the Andromeda the generator sections were composed of solid-drawn steel tubes, 4½ inches in diameter, galvanised externally, while the economiser elements were of tubes 2¾ inches in diameter.

The Yarrow boilers on the Dom Carlos I. differ in some minor respects from the usual construction. The tubes are of solid drawn steel, 1⅛ inch in diameter, except the two rows next the fire, which are 1⅜ inches in diameter, and are slightly curved in order to allow for the expansion due to the effect of the heat. Straight external downcomer tubes are fitted at each end, and a certain number of tubes are also baffled off from the fire to assist in maintaining the uniform direction of the circulation. In the Belleville boilers the feed is controlled by the Belleville automatic device, a float regulating the speed of the pumps, while in the Yarrow boilers the steam supply to the feed pumps is taken from a guarded pipe just above the water level, so that, if the water is high in the boiler it enters the pump cylinder and checks the feeding.

The boilers of the various vessels are tabulated in Mr. Marshall's paper in such a manner as to make a comparison possible, and the deductions which he draws may be taken as a very fair statement of the various types. Considering first space and weight, the horse-power developed per square foot of floor space under natural draft is practically the same for all three types. On the question of weight, however, the two water-tube types are substantially lighter than the cylindrical type, the Yarrow type being the lightest.

On the basis of maximum power the Yarrow type shows by far the greatest advantage, while the Belleville is not materially lighter in this respect than the cylindrical

boiler, owing to the fact that it is not forced.

Taking into consideration the matter of forced draft, the Yarrow boiler can stand forcing to an air pressure of 2 inches for an indefinite period, the limit in this respect seeming to be rather the endurance of the men than of the boiler. The cylindrical boiler cannot stand forcing for a much longer period than four hours, after which period the power could hardly be maintained and the efficiency would fall off, although the speed obtained in this period might indeed be the salvation of the ship, a matter which ought not to be overlooked. Naturally the cylindrical boiler is at a great disadvantage in regard to the quick raising of steam, and in this important matter the water-tube boilers of either type show a marked superiority.

In the opinion of the author of the paper the greatest objection to the Belleville boiler lies in the enormous mass of mechanical detail, the great number of joints being especially undesirable. In this respect the Yarrow boiler has the advantage, but in both cases the use of a number of units complicates the piping and involves many extra fittings. The following conclusions are given as a result of the comparative study of the three types, each being considered merely as a representative of a class:

"The Belleville type is well adapted for maintaining high continuous sea speeds for long periods, and is very economical at high powers. It is comparatively light and well arranged for cleaning and overhaul. Steam can be raised quickly, and large variations in power made readily. It cannot, however, be forced, and has also the objection of great complication of detail and accessories, with consequent liability to derangement.

"The Yarrow type is hardly so well adapted for continuous steaming at relatively high powers, and is not so economical, except when fitted with the feed-heating arrangement recently devised by Mr. Yarrow. It can, however, be forced to almost any extent with safety, and much higher speeds obtained for considerable periods. Steam can be raised quickly, and large variations in power made readily. It is extremely light, and, being simple in detail, has small liability of derangement. Cleaning and overhaul are fairly easy, but the examination of the outside of the tubes is difficult.

"The cylindrical type is about equal to the Yarrow for continuous high-power steaming, though probably slightly less economical. At low powers, however, it is very economical. It can be moderately forced with safety, and is well adapted for ordinary cleaning and overhaul. All its arrangements are extremely simple and unlikely to become deranged. Sea water can be used in it with safety. It is, however, heavy; steam can only be raised very slowly, and large variations in power cannot be made quickly."

The Speed of Battle-ships.

THE importance which is generally attached at the present time to the question of speed in war-ships renders an editorial in the *Engineer* setting forth the other side of the case especially interesting. High speed cruisers are, of course, most valuable things, and the experience of the American fleet at the battle of Santiago showed the value of a battle-ship like the Oregon which can make a spurt in an emergency. The battle of Santiago, however, was not a battle at all in the accepted sense of the term; it was a chase, and that speed is the prime factor in a chase, either for the escaping fleet or for the pursuers no one can doubt. When, however, it comes to a pitched battle, so to speak, when success depends upon manœuvring ability almost as much as anything else, there is another side to the question.

It is indeed true that the fleet of greater speed can seldom, if ever, be forced into action by a fleet of inferior speed, but battle-ships were made to fight and not to run, and the work of chasing a flying enemy may be left to the fast cruisers, while the battle-ships do the fighting. When the enemy's fleet puts to sea it is supposed it is because it wants to fight, in which case guns and armour are of more value than speed. Even if the enemy puts on speed in order to join or combine with another fleet it would hardly be desirable then to catch it unless guns and armour were good enough to insure victory.

When the enemy's fleet is on the run it is almost certain that the inequality in speed

will cause certain ships in the runaway fleet to drop behind, and these "lame ducks" will then be captured in detail, or the swifter runaways must turn and fight. The question of coal supply must also be considered, for the swifter vessel must have a proportionally smaller coal supply than the slower battle-ship, so that the superior speed may in some cases be the actual cause of destruction.

It is most important that a squadron should be homogeneous in the matter of speed if concerted action is to be possible. At the present time the only navy in the world that can put a homogeneous squadron into action is the British navy. A 15-knot squadron of homogeneous ships stands, when these are steaming together in station, to better a swifter fleet of various units, because these last will not be able to perform evolutions together at high speed.

As a matter of fact twelve knots is the highest speed at which fleet evolutions have yet been done, and that has only recently been accomplished. The next trials will be made at 14 knots, but such a speed in evolutions is only possible in a highly trained, regularly commissioned, and homogeneous fleet.

Taking all these questions into account it must be seen that while speed is a very important qualification for all naval vessels, it must not take first place for battle-ships, but must come after the questions of guns and armour. The original idea of the swift cruiser was that it should be able to destroy commerce, attack weaker ships, and run away from the heavier armed and protected battle-ship. Now, however, the idea seems to be that the battle-ship must add to its heavy guns and armour the speed of the lighter cruiser. It is impossible, and perhaps even undesirable to put two such contradictory qualities both in the first place. The heavier vessel cannot be the swifter, nor can the swift ship be so heavily armed; each has its place and function, and in the one speed comes first, in the other fighting power. The battle-ship should be a battle-ship, and the armoured cruiser an armoured cruiser.

If, with improvements in steam machinery greater power can be given to the battle-ship without undue increase in coal consumption, so much the better; but for the heavy fighting machine, a greater speed than can be used in the actual evolutions of battle is as likely to be a handicap as a service.

It is often easy for the general public to join in an agitation for something about which it is impossible that a correct judgment can immediately be formed, and this outcry for fast ships, regardless of the character of the work to be done, is a present instance. The speed of a vessel is but one of the factors of its usefulness and should be given its due share of consideration, but should not be allowed to dominate.

Apart from the question of nominal speed, the actual serviceable speed of a ship is a quantity which will bear consideration. Too many vessels have made high speeds on their trial trips which they have afterwards been unable to realise. The real serviceable speed of a vessel is one which should always be available at any time, and when a battleship can always respond to a call from the bridge for a speed of 16 knots, she is often better than the fast cruiser as to speed, when the vaunted 21 or 22 knots of a trial run is called for in vain.

Gun-power, armour, speed—these are the qualifications for a battle-ship, but they should be considered together, and the former should not be sacrificed to the latter.

Engineering Education.

In the profession of engineering, as indeed in all other professions, the question of the scope and value of the special education which must be obtained is always a live subject for discussion. At the present time this is especially the case since the competitive conditions which are obliged to be faced by industrial Great Britain demand that she shall not fall behind in this respect.

A recent editorial in *Engineering* discusses this question in a manner which demands thoughtful attention, taking as the immediate text the appointments for the science research scholarships for the present year.

After commenting upon the appointments in a general way the statement is emphat-

ically made that the efficiency of the system devised by the commissioners depends upon the way in which it is carried out, and thus comes up the question of the value of examinations. It is beginning to be appreciated that the faculties which make a student a good passer of examinations are not those which are of the greatest value thereafter.

"A strongly receptive mind by no means denotes the creative faculty, and it is creators, not absorbers, of facts, for whom the industries of the country have need."

This whole subject received a thorough discussion at the meeting of the Institution of Mechanical Engineers at Plymouth in connection with Mr. Mayston's paper upon the course of study followed by the students at Keyham. Here it appeared that, while the main aim was that of preparing the students to pass examinations, yet at the same time every opportunity was given the student to develop whatever capacity there might be in him. It is doubtless true that scientific acquirements are not the only requisites necessary for success in life, and it is also admitted that the education and qualifications needed for a man worth £3,000 a year were not necessarily required to fill a situation of £3 a week.

These points may readily be admitted, but the real difficulty lies in the determination of the men who are to fill these different positions in life. Since it is impossible to forecast the future of the student from the beginning, it is desirable that a universal character should be given to the training until it has proceeded to such length that the weeding-out process may safely be begun. It is with this weeding-out process that the uncertainty appears. The mass must be sifted out by educational meshes of wider and wider texture until only the giants remain. The great problem is how to construct this net that the sifting process may be well done.

At the present time examination papers are about the only means available for this purpose, and there seems to be no better expedient for testing a man's capacity for gorging and disgorging facts. If the selection were left to the professors we should need a different class of professors from those now available, and indeed it is a question how any professor who had not himself been through the test of practical life could be of much use in this respect.

It is too often the case that when a man who has had a scientific education fails to profit by his opportunities the fault is laid at the door of the educational establishment and the system is condemned. In many such cases the man would have been a failure under any system, and the old so-called "practical" system, with its apprenticeship of hard knocks and blunders, turned out quite as many failures as do the modern institutions.

The real fact is that the education received at any institution can only be regarded as a preparation for the practical side which must come later, and should be regarded as only a preparation in any case. Practice is continually changing, but fundamental principles can never change, and that education best fits a man for success in life which grounds him thoroughly in those principles which are at the bottom of all applied science and art, while at the same time it impresses upon him that what he is learning is only a foundation upon which he must erect the superstructure himself. Too often the successful cramming which has enabled a student to pass an examination with flying colours has really unfitted him altogether for subsequent success in life, not only because it has failed to teach him the things which he must know in order to attain success, but because it frequently leads him to believe that the mere passing of the examination in itself constitutes success. Examinations are all very well in their way, but the student himself should be his own strictest examiner, and his examination paper should not be that set before him by his teachers, but that which his own ambitions for the future may set before him.

Review of the Continental Press

Steel Castings for Structural Work.

The new Alexandre III. Bridge across the Seine at Paris has already been described in the pages of this Magazine, and other accounts have also been reviewed in these columns, but the work contains so much that is of professional and technical interest that some of the details of its construction have more than an immediate application. For this reason some review of a portion of the official description of the work prepared by the engineers MM. Résal and Alby for the *Annales des Ponts et Chaussées* is here given, especial attention being directed to the steel voussoirs and the methods of casting them.

While the bridge is wholly metallic yet it is designed upon principles almost identical with those involved in the design of a masonry arch. There are a number of separate arch ribs, but each consists of blocks or voussoirs, performing similar function to dressed stone voussoirs in a masonry structure, and while these are bolted together there is intended to be little or no tension upon the bolted joints, the curve being such that there is no bending moment, the entire arch being in compression. Since the arch is hinged at the crown and at the springings, the curve of pressure can be very definitely determined for various loadings, and upon the mean curve of pressure the entire shape of the arch is based, a segment of a circle being used for the intrados and a curve of several centres for the extrados. From the original drawings a set of working drawings were made, giving the shapes of the voussoir by rectangle co-ordinates, thus avoiding the necessity of sweeping the great curves full size in the workshop, and these details were used for the actual construction.

Owing to the limited time available for the completion of the bridge, in view of the approach of the exposition, the work was entrusted to five of the most prominent establishments in France, *i. e.*, the works at Châtillon, Saint-Chamond, Creusot, Saint-Etienne, and Firminy, each of these establishments being given the privilege of making the parts according to its own methods, keeping in strict conformity with the drawings and specifications.

The account shows in a very interesting manner the different methods employed by the various firms in executing and assembling the work. In some cases platforms of concrete or timber, covered with sheet-iron, were constructed, upon which the curves of the arch were laid out from the co-ordinates given on the drawings, while in others carefully levelled blocks were set at points corresponding to the joints between the voussoirs and used for the verification and assembling of the parts. At Saint-Etienne, where the character of the soil is such as to make solid foundations difficult, the curves were traced twice, in order to correct for variations which appeared during the successive assembling of the arches.

The various methods of moulding and casting the steel pieces form a most interesting study, as showing the different practice of these noted works. The general scheme of moulding was the same in all cases, a three-part flask being used, the middle portion containing the pattern of the ribbed plate forming the voussoir, and the upper and lower parts holding the cores. In all cases the castings were poured lying on the side, the flask being blocked up at an angle, but the gating and venting was not the same in all cases, and the angles varied greatly. A sheet of diagrams showing the details of moulding and pouring in the various cases is given with the original paper and forms an interesting study in foundry methods.

The different establishments proceeded differently in regard to the cooling and annealing. In most cases the moulds were allowed to remain untouched for at least 24 hours, after which the castings were removed and annealed, but at Firminy several days were allowed to elapse before the moulds were touched. In some cases the castings were partially uncovered, in order to allow the cooling to take place in such a

manner as to prevent warping, but this did not seem to be considered necessary in all cases.

The practice in regard to the annealing is also of interest, as it varied both in duration and temperature in the various works. At the Chatillon works the casting was raised to a temperature of 950° to 1,000° C., which required about 30 hours; it was maintained at this heat for about 6 hours and then gradually allowed to cool, this latter operation taking 72 hours, making a total of 108 hours. At Saint-Etienne the operation was about the same except that the cooling was accomplished in 30 to 36 hours, the whole operation being completed in from 72 to 80 hours. The operation at Firminy was peculiar. A gradual heating to 900° was given, lasting from 35 to 40 hours, and the furnace doors were then opened and the temperature allowed to fall suddenly to 600°; the doors were then tightly closed and the casting allowed to cool during 45 hours.

The practice at Creusot was to place the casting in an oven as soon as practicable after pouring, where it was allowed to cool slowly. This attained a portion of the result intended to be accomplished by the annealing, and rendered the subsequent operation much shorter. The cooled casting was reheated to 1,000° C. and kept there for two hours and then cooled in 12 to 14 hours.

Since the tests showed the various products to come up to the standard required by the inspecting engineers it is evident that the various methods of treatment were based on successful experience with the metal employed in each case. The average tensile strength was 75,000 pounds per square inch, with an elastic limit of 40,000 pounds and an elongation of about 18 per cent.

The Resistance of the Air.

ONE of the elements of much importance in connection with computations for rapidly moving vehicles, whether through the air or on the surface of the earth, is that of the resistance offered by the atmosphere at various speeds. In order to stimulate investigation in this line of work, the *Société d'Encouragement* offered a prize for the best experimental study of the subject of the resistance of the air to moving bodies. A report upon this matter has recently been made by M. Barbet, for the committee on mechanic arts of the society, and the two papers which merited awards are now published, together with the original report, in the *Bulletin* of the society.

A number of papers were presented in response to the offer, but among these only the communications of M. l'abbé Le Dantec and of M. Canovetti were considered worthy of awards. These two papers are, without doubt, valuable contributions to the meagre stock of knowledge of the subject. That of M. Le Dantec is a record and discussion of experiments upon the vertical fall of planes under known conditions, the experiments having been made with very ingenious apparatus in the chapel of the Conservatoire des Arts et Métiers. The paper of M. Canovetti is a discussion of experiments made with bodies of various shapes and surfaces suspended from a trolley running on a long stretch of inclined wire, forming a sloping catenary of known shape and descent.

The apparatus used by M. Le Dantec was simple in conception and principle. A surface of given area, in this case one square metre, was arranged so as to fall vertically, being guided by a tightly stretched vertical wire. At the commencement of the fall there is an accelerated movement. The resistance of the air increases with the velocity of the fall and retards the movement and when the atmospheric resistance becomes equal to the weight of the falling body, the acceleration ceases and the motion becomes uniform. In the detailed record of the experiments a full description is given of the ingenious and accurate recording apparatus by which the exact moments of starting and stopping were electrically recorded on moving bands of paper, and the elimination of personal errors thus accomplished added much to the reliability of the results.

For a full account of these very interesting studies the reader must consult the original paper, but the final results may be given here. In the first place a square surface of one metre area, plane on both sides, moving at a velocity of one metre per second, encounters an atmospheric resistance of 81 grammes. Secondly, plane surfaces

of the same area, but of various shapes, experience different resistances, and M. Le Dantec has discovered that the resistance of the air to surfaces of different shapes is proportional to the lengths of their various perimeters. Thirdly, within the limits of his experiments, M. Le Dantec has verified the law that the resistance of the atmosphere is proportional to the square of the velocity. In the experiments it was evident that eddies and currents in the air made very material differences in the results and that tests, to be comparable, must be made in still air.

The experiments of M. Canovetti were intended to be an improvement upon former ones made with carriages descending inclined planes. In the earlier experiments of this kind the frictional resistance of the carriage formed an important source of error, and the limited length of the planes permitted only small velocities to be studied. The apparatus of M. Canovetti enabled the frictional resistance to be much reduced, while the horizontal distance between the ends of the wire was 280 meters with a fall of 71.2 meters, a gradient of about 25 per cent.

The principal sources of error in these experiments lay in the fact that the varying slope of the catenary affected the velocity, and in the manner of determining the velocity by the use of an ordinary stop watch in the hands of individual observers. Nevertheless, the experiments gave interesting and valuable comparative results for bodies of various shapes tested under approximately the same conditions, and for this reason the paper was considered worthy of award.

The results in general agree very well with those of M. Le Dantec, the resistance of a plane of one metre area at a velocity of one metre per second being 80 grammes for a circle and 90 grammes for a rectangle. A right cone of an altitude of 1.5 times the base-diameter gave a resistance of 60 grammes, while a hemisphere with convex side forward showed only 22.5 grammes. When the hemisphere had formed upon its flat surface a cone of an altitude double the diameter of the base, the air resistance was reduced to 15 grammes, or only one-fifth that of a circular plane disk of the same diameter.

These tests show very conclusively the marked influence which the form of the moving body has upon the wind resistance, and may render material assistance in the design of machines for aerial navigation.

It is to be hoped that these trials are but the beginning of more extended experiments upon a larger scale and under varied conditions, in order that the very important subject of wind pressure upon engineering structures may be elucidated.

Petroleum Motors.

THE high economy which may be obtained by the complete combustion of liquid fuel in an internal-combustion motor is now generally conceded, and as a result there have been numerous attempts to design motors which shall prove acceptable for general use. The Diesel motor has been fully noticed in these columns at various times, and now we have the Dopp motor, which was discussed at a recent meeting of the *Verein deutscher Maschinen-Ingenieure,* the account being published in *Glaser's Annalen.*

Dopp maintains that the high compression advocated and used by Diesel is not necessary to the attainment of superior thermal economy, and claims that equally good results can be secured by the use of vapourised petroleum, drawn into the cylinder with the proper proportion of air, and burned under practically the same conditions as obtain when gas is used in a well designed gas engine.

It seems to be generally admitted that the main element in the economy of a petroleum motor lies in the complete combustion of the fuel. While this is secured by providing a compressed atmosphere, it does not appear that it is necessary to use a compression materially greater than is now employed in the gas engine. The Dopp motor does not differ in general construction from an ordinary gas engine, except that the petroleum fuel is gasified by the heat of a lamp before it is drawn into the cylinder, and the excellent economy which appears in the regular service is claimed to be due only to the completeness of the combustion, attained by a thorough mixture of the fuel with the proper quantity of air.

Herr Dopp gives figures from a number of his motors in daily use which show a

consumption of 0.197 to 0.240 kilogrammes of petroleum per horse-power-hour, the lower result being obtained with a 10 h. p. motor after it had been in practical service for more than 11 months. This result is better than was attained by the Diesel motor of 20 h. p. tested by Professor Schroter, although under less favourable conditions.

Herr Dopp maintains, as has been claimed by others, that the Diesel motor by no means realises in practice the theory enunciated by its designer, and shows that some of the fundamental points which, according to the theory are essential to the highest economy, are distinctly controverted in the working of the motor. From this he deduces that the high economy of the Diesel motor shows that the theory is not sustained.

An important feature of the motors constructed by Herr Dopp lies in the fact that they can be constructed and operated in a satisfactory manner for small powers, good results being obtained with motors of 2 to 5 h. p., while the construction of the Diesel motor is such that it does not appear advisable to make them for less than 20 h. p.

Regardless of the theoretical questions at issue, there seems to be little doubt that very simple, efficient, and convenient petroleum motors can be made upon the same general design as that already in public use for gas, and that care in design and in the correct proportion of air to fuel supply can, with a moderate degree of compression, insure such a complete combustion as to leave little or no trace of soot either in the cylinder or in the exhaust gases. Under such circumstances there can be little doubt that the petroleum motor has a most useful future before it, especially for small powers.

Masonry Chimney Construction.

NOTWITHSTANDING the attention which has been directed of late to the subject of mechanical draught for boilers and furnaces, there exists a strong prepossession among many engineers for the use of chimneys, and the masonry chimney still holds its pre-eminent position as a means of procuring a draught of air for the combustion of fuel.

The subject of chimney proportion has been frequently discussed, and various formulas, mostly based on the treatment of Rankine, have been enunciated, but it is an undoubted fact that empirical methods are for the most part used by those engaged in actual chimney construction.

In recent issues of the *Zeitschrift des Vereines deutscher Ingenieure*, the matter is treated from a theoretical and practical standpoint by Professor G. Lang, while in the *Mittheilungen aus den Königlichen technischen Versuchsanstalten* is given a report by Herr Max Gary of the tests of chimney masonry, made under the auspices of the Royal Testing Bureau, these papers together forming the latest contributions to the subject of chimney construction.

Beginning with the conditions of temperature, atmospheric pressure, and the expansion of gases by heat, Professor Lang deduces a simple formula for the computation of chimney height, the application of which he illustrates by several examples. This formula contains coefficients for chimneys of various sections, and enables a height to be deduced which will give any required velocity of gases for a given rate of combustion.

Passing on the details of chimney construction, Professor Lang discusses in succession the questions of materials, foundations, and stability, and gives some very complete investigations of the stresses in different portions of the structure under various conditions. The subject of the action of wind pressure is considered, and a brief table is given of constants to be used in his formulas for chimneys of different shapes, with the idea of rendering the discussion of immediate practical use. In fact the whole study of the subject by Professor Lang is intended to serve as a standard for practice of the German boiler-inspection office, and had its origin in the instructions of the Prussian Minister of Commerce and Industry.

The paper by Herr Gary is of an altogether different nature, but is none the less practical on that account. The Royal Technical Testing Laboratory at Charlottenburg, under the direction of Professor Martens, has been making for some time a series of actual tests of brickwork and other masonry under conditions approaching as nearly as possible those which obtain in chimney construction, and it is upon these tests that Herr Gary has reported.

The tests were instituted to examine into the following conditions:

1. Resistance of the single pieces to pressure, and to the action of weather, water, and acid vapours.

2. Resistance of mortar joints in general.

3. Resistance of mortar when the force acts at right angles to the construction, as in the case of wind-pressure.

4. Resistance of the vertical joints to circumferential pressure.

The whole elaborate plan of operations is detailed at length in the report, and to it the reader must be referred for the particulars, but some of the results will be of interest. The mean of a number of crushing tests upon brick alone was 671 kilogrammes per square centimetre, or about 613 tons per square foot. The compressive resistance for mortar joints from 1 to 5 centimetres thick, and 28 days old, ranged from 230 down to 54 kilogrammes per square centimetre, the higher values being for the thinner joints; and the general mean of 300 tests was 131.7 kilogrammes per square centimetre, or about 120 tons per square foot. Tensile tests of mortar joints showed figures ranging from 0.8 to 3.9 kilogrammes per square centimetre, or from 10 to 55 pounds per square inch, the mortar in the highest case being 90 days old.

The transverse and longitudinal trials were practically shearing tests, and gave the resistance of the combined brick and mortar, the rupture taking place through the mass and breaking both portions of the section. For mortar 90 days old the resistance to horizontal shearing was about 14 kilogrammes per square centimetre or about 200 pounds per square inch, while against vertical shearing it was about 9 kilogrammes, or about 130 pounds per square inch. Crushing tests made of brickwork masonry 9 months old gave an ultimate crushing resistance of 239 kilogrammes per square centimetre, or 218 tons per square foot, figures which may be of service in other connections than that of chimney construction.

Pulverised Fuel.

THE attention which is now being directed toward the prevention of smoke in connection with the generation of power by the combustion of coal has awakened renewed interest in the possibilities of pulverised fuel. An exhaustive review of the past and present practice in this branch of engineering appears in a series of articles in the *Schweizerische Bauzeitung*, and in view of the schemes which have recently been discussed, this review is of present value.

Pulverised fuel has been the subject of experiment since 1831, when Henschel, at Cassel, charged air with coal dust and used it for firing brick-kilns, and for welding and other smithy operations. Nearly 30 years later Pütsch attempted to use coal-dust firing for glass furnaces in England, and in the 70's Crampton made a number of applications of the principle to metallurgical operations.

In America the experiments of McAuley about 1881, and Hathaway in 1886, are well known, and at the present time the experiences of Wegener and others in Germany and elsewhere are attracting considerable attention.

Three fundamental principles are laid down for the successful use of pulverised coal as fuel. (1) The combustion chamber must be maintained at a high temperature; (2) the powdered fuel must be delivered into the midst of the entering air current, and the intimate mixture of air and fuel delivered into the combustion chamber in an uninterrupted stream; (3) the particles of coal must be maintained suspended in the air until they are fully consumed.

This last condition is very important, since if the particles fall out of the air current to the bottom of the combustion chamber mere coking will take place instead of a complete combustion.

A distinction must be made between powdered fuel and the ordinary coal dust which is found at every mine. The coal for use in air-blast firing without grates must be finely ground in a mill, so that it will pass a sieve of 900 meshes per square centimetre, and must be entirely free from any larger particles.

The first of the above conditions requires especial consideration in connection with internally-fired boilers, since the proximity of boiler surface to the burning dust will chill the furnace to an extent sufficient to make the combustion imperfect. In order to avoid this it is necessary to line the

furnace with fire-brick, which by attaining a high temperature prevents the chilling of the flame and acts to equalise the temperature. There is no loss of heat by using such a lining, as the fire brick occupies only an intermediate position and the heat is ultimately transferred to the boiler surface.

The second condition, that of mixing the fuel with air and feeding the mixture into the combustion space, is the one which must be fulfilled by the construction of the apparatus, and the ingenuity of designers is mainly exerted in this direction.

The third condition is mainly dependent upon the fineness of pulverisation, and it is the cost of grinding the coal to the necessary degree of fineness which usually limits the commercial application of any process.

The Wegener furnace, about which much has been said of late, is an attempt to apply pulverised coal methods similar to those which have been used successfully with low-grade hydrocarbons, and with petroleum refuse, in Russia. In this apparatus the finely powdered coal is distributed into the incoming air by a revolving sieve, and the mixture is then driven into the combustion chamber by a steam jet. A firebrick lining permits the high temperature to be maintained, and as this soon becomes white hot, any slight inequality in the rate of firind does not permit a sudden chilling. The ash which exists in the coal is mostly fused to a liquid slag, which runs out a tap hole below, and it is found that there is no greater accumulation of dust in the boiler flues than occurs with ordinary firing.

A number of tests, conducted with especial regard to smoke-prevention, have been made in Germany, and the details of these do not show any extraordinary evaporative performance, from 8 to 9 pounds of water per pound of coal being the average result. The absence of smoke was practically attained in all cases, however, whenever proper precautions were taken to provide sufficient fire-clay surface in the combustion chamber to prevent chilling of the flame. This has been found difficult of accomplishment in the case of water-tube boilers, unless an entirely separate combustion furnace is constructed, since the presence of the tubes containing water checks the combustion to an extent sufficient to cause smoke to be produced.

The use of pulverised fuel can hardly be recommended on the score of economy, as the evaporation is little if any higher than that obtained by ordinary firing, while at the same time the cost of grinding the coal must be included. When, however, it is imperative that no smoke be produced, it appears that this is one of the various methods by which that desirable result may be attained.

The Siberian Railway.

THE progress of the Siberian railway has been noted in these columns from time to time, as the importance of the work demands, and we now note an excellent account in *Glaser's Annalen*, of the operation of that portion extending from Tcheliabinsk, the starting point in the Urals, to Irkutsk, near Lake Baikal. This completed part of the road is divided into two sections, the first extending from Tcheliabinsk to the Obi, a distance of 880 miles, and called the Western Railway of Siberia, the second, the Central Railway of Siberia, reaching from the Obi to Irkutsk, 1,136 miles more, or a total of 2,016 miles. There is also a spur extending from the station of Taiga to the city of Tomsk, a distance of 54 miles, which is now in operation.

The construction of the western portion of the road lay over a vast plateau, almost treeless, and the principal engineering features of interest are the bridges. Of these one of the most important is that over the Irtisch at Omsk. This consists of six truss spans of 350 feet each, and two shore spans of 75 feet. There are similar bridges over the Tobol and the Ischim, there being four spans in the first case and two in the second, all of 350 feet each. The bridge over the Obi has seven spans and a total length of 2,600 feet. All these bridges are of wrought iron and were built at the Wotkinski works in the Ural. Many details of the roadway construction, as well as the buildings and other fixtures are given in the article, and the work appears to be well done in standard Continental style.

The total cost of the Western Railway of Siberia was 46,124,698 rubles (about £4,960,000) while the estimated cost was 47,369,367 rubles (about £5,100,000) so that we have the unusual result of the cost of the actual work falling below the estimate.

REVIEW OF THE AMERICAN PRESS

The Sanitation of Havana.

IT is generally recognized that an important portion of the work of the soldier in connection with military operations in new countries is that of executing such engineering work as may be necessary for the health of the occupants, and it is sometimes the case that such work is necessary in places which have previously been occupied by civilized people. An example of the latter case is found in the city of Havana, and a very interesting account of the conditions there found by the United States troops is given by Mr. E. Sherman Gould in *Engineering News.*

Taking the death rate as a measure of the healthfulness of a city it will be seen that Havana cannot be given a very favorable place, the rate being at present estimated at 30 per 1,000. This must, of course, be taken in connection with the natural disadvantages of the location. About 20 per cent. of the deaths are due to pulmonary diseases, these being attributed to the raw, damp weather of the winter season, together with the scanty clothing worn by the poorer classes. Yellow fever is endemic and paludic fevers and rheumatism prevail.

According to the population and the area given by Mr. Gould the density of population is high, reaching about 100 persons to the acre, and were it not for the fact that the general mild climate causes all houses to be thrown open to the air, a much higher death rate might be expected.

The objectionable features of Havana are the low-lying topography, the absence of anything like decent sewerage, the slight tides of the bay into which all drainage is delivered, and the need of good paving. Most of the houses are built directly upon the ground, without cellars and the soil beneath is often saturated with filth and moisture. Cesspools are common, and where connection with a sewer is made it is simply to relieve the liquid overflow, the unlined hole in the ground being cleaned only at long intervals. These cesspools are generally within the limits of the house itself, and must constitute an active source of disease.

The streets are irregularly paved, and generally in bad condition, and up to the time of the occupation by United States troops there had been no systematic street cleaning nor removal of garbage, this work being left for the sudden and violent showers which are of frequent occurrence. The one redeeming feature of the city, from a sanitary point of view, is the excellent and abundant water supply. This is brought from the Springs of Vento, a distance of seven or eight miles and distributed by nearly 90 miles of cast iron pipe. There is much waste of water, through defective plumbing and careless habits, and Havana might be cited as an excellent example to show that a high consumption of water does not necessarily add to the healthfulness of a city.

Since the military occuption, the care of the streets and sewers has been placed in the charge of the Engineer Department of the United States Army, and much has been done in the way of superficial improvement. The streets are regularly cleaned, and refuse carted away, loaded on scows, and dumped out at sea. Many of the sewers have been opened and cleaned and in all a great change for the better has been made in the appearance of the city.

Nothing has yet been done in the way of fundamental improvements, and it is hardly probable that any will be attempted during the military occupation, although it is more than probable it would be better so done than if left to the civil government which will probably have many other things to undertake.

The first step to be taken should be the establishment of a complete and efficient system of sewerage. This involves some satisfactory plan for the disposal of the sewage, as its discharge in a crude state into the almost stagnant bay is by all means to be avoided. It would probably be diffi-

cult to install a purification plant, owing to the absence of suitable disposal areas, while the alternation of festering heat and torrential rains would interfere with satisfactory operation. Mr. Gould suggests the tunneling of the hills and the delivery of the sewage into the littoral current beyond the Morro Castle, using both pumping and gravity for the maintenance of the discharge. This would doubtless be an expensive plan, but would make a final solution of the problem.

The repaving of the city should be done in connection with the sewerage works in order to avoid a prolonged tearing-up of the streets, and either asphalt or vitrified brick would be suitable, the latter probably the best in case of the settlement of the disturbed earth.

"Enough has been said to show that the problem of sanitation in Havana is by no means a simple one. It will be a gigantic enterprise to take in hand a city of some quarter of a million inhabitants, with narrow and crowded streets, and design and execute a complete and adequate system of sewers and street improvements with a minimum degree of interruption of traffic and inconvenience, and maximum economy. It is clearly a case where the highest special talent is required to prepare a carefully matured plan which shall best meet the peculiar conditions of the problem."

Heating by Exhaust Steam.

THE use of exhaust steam for heating purposes is well-known in connection with factory power plants, but until recently it has not been considered as a part of the practice of central power stations. Recently, however, the electric-lighting company operating in the city of Providence has considered the feasibility of using the exhaust steam from its engines for the purpose of supplying heat to a surrounding district. Before proceeding with the execution of this plan a report was had from Professor J. E. Denton as to the probable cost at which exhaust steam could be supplied to the buildings, and from his report, as published in the *Engineering Record* we abstract some interesting information upon the subject.

At the present time the engines are operated condensing, and the proposed change would not only require the abandonment of the vacuum, but would also involve the operation of the engines against a back pressure of about six pounds above the atmosphere. This would make the absolute back pressure against which the engines must exhaust equal to about sixteen pounds.

The result of the calculations of Professor Denton is, that for the engines concerned, taking into account any saving due to dispensing with the air pump for operating the condenser, the change from condensing to non-condensing, with six pounds exhaust pressure above the atmosphere, would increase the consumption of fuel about 42 per cent. of that required for operating condensing, and that the boiler pressure must be raised from 150 pounds at the lighting station to about 200 pounds above the atmosphere, and at the power station from 150 to 175 pounds above the atmosphere. It then follows that 30 per cent. of the fuel to operate the engines noncondensing is the increase of the fuel expense imposed by the use of their exhaust for heating.

While this seems like a large proportion of the steam cost to be used for heating purposes, yet it is less than is found to be the case when steam is generated especially for heating independently of the engines. It has been found, in the New England mills, that the fuel consumption is about the same when the exhaust steam is used for heating as it is when the steam for heating is generated independently of the power plant. In many of the mills both steam and water power are used, but a certain quantity of steam is required in the dye-house and elsewhere at all times. When the engines are running, in times of low waters, the exhaust steam is used for heating, and when the mills are operated by water power the heating must be performed by live steam generated for the purpose, and the coal consumption can therefore be compared very readily.

In a valuable paper upon the use of compound engines for manufacturing purposes presented before the American Society of Mechanical Engineers by Mr. Charles T. Main, the relative consumption for various kinds of engines is given upon the as-

sumption of the use of various percentages of the exhaust steam for heating. This paper shows that when all the exhaust steam of an engine is used for heating purposes there is no material economy in using a compound engine, since the back pressure necessary for the heating system prevents the attainment of an expansion ratio otherwise economical.

Taking the case of a 1,000-h. p. engine operating compound-condensing, it is assumed that the fuel cost would be 1.75 pounds per h. p. hour, while if the same engine is run high-pressure, *i. e.*, exhausting into the heating system at atmospheric pressure instead of into a vacuum, the fuel consumption would be 3 pounds per h. p. hour, all the fuel being charged to power. As a matter of fact, however, all the fuel should now not be charged to power, but by far the larger portion of it belongs to the heating account and instead of being a power plant such a combination becomes a heating plant with a side issue consisting of the power end of the establishment. Instead of generating high-pressure steam and then passing it through reducing valves on its way to the heating system, the engines act as reducing valves, and abstract energy, as a sort of by-product, from the steam ultimately used for heating.

That this can be done to advantage hardly appears from Professor Denton's report, since, in order to pay for the cost of heating the 25,000,000 cubic feet of space under consideration, and pay the company a profit of 20 per cent., it would be necessary to make a charge of 35 cents per square foot of radiator per season This corresponds to a charge of $10.02 per ton of coal, used in an isolated plant while as a matter of fact coal can be purchased in Providence for $3.00 per ton, and Professor Denton's own estimate for isolated plants at this rate comes to about 8.7 cents per square foot of radiator surface per season.

Apart from the question of cost involved in the operation of the plant there are other considerations which should be taken into account. The management of central steam plants in large cities has not been found especially easy or profitable; the care of a network of underground piping, with all the losses due to leakage, condensation, etc., is both expensive and unsatisfactory. While the report of Professor Denton assumes to include all the regular expenses of this portion of the scheme, yet experience has shown that the frequent emergency expenses form a large and uncertain element in the cost.

If the heat in the large volumes of steam discharged at the numerous light and power stations could be directly utilized, without the added expense and inconvenience of an extended distribution, it might well be worthy of consideration, but otherwise the combination of a heating and power plant may well be looked upon as a risky experiment.

International Testing Methods.

THE activity and the extent of current interest in the unification and standardization of testing methods is evidenced by the fact that three American engineering journals—the *Engineering News, Engineering Record,* and *Railroad Gazette*—published in full the address of Prof. Mansfield Merriman, as chairman of the American section of the International Association for Testing Materials, at the second annual meeting of the section held at Pittsburg, Pa., in August.

The history of the movement, as sketched by Prof. Merriman, is one of gradually accelerating progress. The first half of this century was a time of "great progress in the theory of elasticity and slow growth in knowledge of the properties of materials under stress." With 1850 began the construction of large testing machines for special purposes; 1870 introduced the period of recognition, by manufacturers, "that physical tests of metals were imperatively necessary in order to secure uniformity of product." Another decade ripened the seeds of the perception that these physical tests must themselves be brought to a uniform basis, and the germ of the present flourishing movement was planted in 1882 by John Bauschinger, when he brought together a number of German experimenters, at Munich, to discuss means for promoting this needed uniformity of testing methods. Successive formal conferences were held at Dresden in 1884, at Berlin in 1886, at Munich in 1888, and at Vienna in 1893. Dele-

gates attended from other countries; wide interest was displayed in the reports of the proceedings, published in Bauschinger's *Mittheilungen;* engineering circles everywhere recognized the importance and value of the discussion—"in short, the movement assumed an international character." The French government had appointed, in 1890, a commission to formulate standard methods for testing materials of construction; its report, presented in 1894, is one of the most valuable contributions to the subject; but France recognized that a commission of a single nationality could not deal finally with the matter, and since 1895 has warmly supported the work of the International Association.

"In 1895, as a result of the four preceding conferences, the fifth conference met at Zurich, all European countries, except Turkey, being represented. The United States government was represented by an army officer and the American Society of Mechanical Engineers by a delegate. At this congress the International Association for Testing Materials was formally organized." "The meeting at Zurich hence assumed an importance far greater than any preceding conference, and it may be called the first congress of the International Association." The second congress was held at Stockholm in 1897, by which time the membership present had grown to 361, representing 18 countries. It was there resolved that the next congress should be held in 1900, in Paris, and the council was "authorized to appoint technical committees to make reports at that time on special problems relating to the work of the Association."

The announcement by the authorities of the Paris Exposition, however, of a special congress on the subject of materials, has made it necessary to reconsider the plan, and either abandon the projected congress, so as to co-operate with the one announced by the Exposition's authorities, or else hold the Association congress in London during the preceding week. The total membership, which in 1897 was 1,169, in 1898 was 1,488 and now is probably nearly 2,000. Germany leads, with 387 members. Next in order come Russia, 315; Austria, 158; England, 83; Switzerland, 83; the United States, 68; Sweden, 68; France, 66—all figures being from the 1898 returns. The United States membership is now approximately 125.

It is interesting to note the distribution of topics to be considered at the 1900 meeting. Nineteen technical questions have been proposed and assigned to international committees. Six of these are on iron and steel—the more important being concerned with international specifications for inspecting and testing; eight are on cement and mortars; and one each on paints, lubricants, stone and slate, tile pipe, and dry rot in wood. The number assigned to iron and steel is not at all surprising, in view of the increasing international range of the trade in structural materials; the space assigned to cement seems "abnormal; but it should be remembered that in the testing of hydraulic cement the personal equation of the observer enters to a far greater degree than in the case of metal, and that its rapidly increasing use demands the immediate perfection of methods which will render comparable the work of different laboratories."

The aims of the Association are so important, and membership in it is so freely open that it is surprising it is not even larger. Sixth place, with a representation of 68 in 1898, is not an adequate showing for a country of the industrial importance of the United States. Every day sees more firmly fixed the custom of buying and selling engineering work and products of every class—raw and manufactured—by exact specifications. Every day, therefore, makes it more vitally necessary that buyers and sellers should reach a standard for the interpretation of the specifications, and a standard method of making the tests. The farther trade goes from home, the greater the need of uniformity of agreement as to methods of inspection and examination. The Association deserves earnest support in its efforts toward establishing those standards and that exactitude of working which not only belong to good engineering, but which serve to establish the confidence between buyer and seller upon which all trade—especially export trade—is based.

The Size of Septic Tanks.

THE *Engineering News* makes the description of the septic tank at Champaign,

Illinois, the text for a well considered editorial upon the "proper ratio between tank volume and average daily sewage flow." The question is suggested by the extraordinary difference, as to the ratio, between the Champaign works and those at Exeter. "The Champaign tank has a capacity of only 22,200 gallons, for a dry-weather flow which is already 300,000 gallons a day. * * * With the normal daily flow of 300,000 gallons, the tank is filled 13½ times each 24 hours. * * * In marked contrast to this is the English practice of providing a tank capacity equal to 24 hours' dry-weather flow, which is occasionally reduced to some eight hours by the admission of limited quantities of storm water."

The reviewer naturally remarks that: "Whatever differences may exist between the composition of English and American sewage, and between ground and storm water as the respective diluents, they go only a little way in explaining why the English tanks should be a dozen times as large, relatively, as the one at Champaign. Either the first are too large or the latter too small, providing they are seeking the same ends." Unfortunately, the meagreness of comparable data prevents any close or accurately instructive comparison; so far as the comparison can be made, upon the character of the effluent, it seems to indicate that the Champaign tank is too small—but so little inferior in its working to the Exeter plant that the latter appears to be too large. And this latter the *Engineering News* apparently inclines to hold the worse fault of the two. If its contentions are admitted, excess of size is not only needless—it is disadvantageous.

The functions of the septic tank are "chiefly the removal of suspended matter," partly by sedimentation and partly by anaerobic bacterial action—or putrefaction—breaking down the solid organic matter into forms in which, in the effluent, it is readily nitrified by the aerobic bacterial action succeeding the tank treatment. But "it appears to be a decided disadvantage to allow the anaerobic bacteria to work on the sewage proper longer than is required to break down the organic matter, for if the putrefactive process is carried too far, the changes effected will be inimical to the aerobic bacteria which are to complete the work." The *Engineering News*, therefore, inclines to fix upon four hours as the proper limit of time for the sewage to remain in the tank. "For removal of suspended matter alone, it is very doubtful whether the results obtained after four hours' sedimentation are worth the extra expense for tank capacity, or could not be better attained in some other way." For, as is pointed out, any solid organic matter not broken down at the end of that time will remain in the tank with the sludge, and the anaerobic process will continue in it regardless of drawing off of the effluent, until it finally passes into products escaping at some succeeding emptying of the tank. The conclusion is put in the query: "Can it be profitable to build septic tanks larger than is required for sedimentation?"

It must not be forgotten that the bacterial process can be carried on quite independently of the septic tank. At Sutton, Surrey, where a very high purity of the effluent is claimed, no sedimentation nor tank treatment of any kind is followed; the sewage passes to the bacterial bed after simple straining through a perforated metal screen, to remove the larger solids. The review concludes with a very interesting contrast of English and American ideas regarding stream pollution. For a long time in the United States it received hardly any attention at all; now, "There is a tendency to leave all or nothing to nature; to pollute water most shamefully, until it can be borne no longer, and then to insist on an effluent better than the water into which it is turned. Earlier action and more moderate aims would be far wiser. * * * Our English cousins are not trying to turn their sewage into drinking water, while we have been regarding such a result as at least desirable."

"An effluent better than the water into which it is turned" sounds like an exaggeration, but a case was actually in the courts of Ohio, not many years ago, in which a certain village was enjoined from discharging its sewage effluent into a local stream, the waters of which were many times worse than the effluent and would have been distinctly improved by receiving it. But, after all, it is much wiser to be over-rigorous in excluding impurity than over-lax in admitting it.

Technical Instruction by Correspondence.

Among the valuable papers recently presented before the annual meeting of the Society for the Promotion of Engineering Education was one by Professor Edgar Marburg, of the University of Pennsylvania, upon correspondence schools.

After showing the deficiencies in the general school instruction in the United States and indicating the changes which must come about if the gaps in the existing educational system are to be filled, Professor Marburg proceeded to discuss the subject of instruction by correspondence.

"Sprung from seemingly insignificant beginnings, some ten years since, its growth, notably during the past two or three years, has been little less than phenomenal. It is a significant fact that the correspondence schools have found their largest following among our technical workers, especially those of our shops and factories. Thus a single institution devoted principally to engineering and the mechanic arts claims a total enrollment of upwards of eighty thousand students, a number four times greater than that of only two years ago. Whatever the merit of the system, these figures bear striking evidence that our craftsmen are keenly alive to the defects in their education and are grasping eagerly at such opportunities as present themselves."

As regards the real value of the instruction imparted by these institutions, it is not easy to determine. In the first place they are openly and avowedly money-making enterprises, and while thus altogether as legitimate as any other business enterprise they are on quite a different footing from the regular seats of learning. It is naturally difficult to obtain accurate and precise information concerning private business organizations of this kind, and the statistics which are freely published by the regular schools are either withheld on the grounds of business expediency, or, where furnished, cannot always be accepted with confidence. Testimonials are made prominent, while complete lists of graduates and students are not allowed to appear. Although these matters have no direct bearing on the intrinsic value of the instruction itself yet tactics of this sort naturally give rise to prejudice and distrust. At the same time it is possible to make an investigation, more or less complete, of the method of instruction adopted, and this Professor Marburg appears to have done.

Instruction papers take the place of text books, and with these are provided examination papers containing questions for the student to answer. The answers are then corrected by the instructors, and after a final examination upon the special subject, a certificate of proficency is awarded.

While a certain degree of instruction may thus be imparted, yet it is very certain that only a very limited number of those attempting to study by correspondence can be expected to succeed. It is one of the advantages of the system, however, that it is largely undertaken by those who are really ambitious, and desirous of success. Few men would undertake to acquire an education by laborious night work, without the aid and encouragement which can only come from personal contact and inspiration from the instructor, unless urged on by a strong desire for information and intellectual advancement, and it is just because of this feeling among many of the students that any success is had. Some of these men are terribly in earnest; they see the value of education to others, and are willing to make the fight to obtain it; and to them the correspondence school is the one path by which they can reach the desired goal. Some, of course are led to undertake a course by solicitation, or by the allurements of skilfully prepared advertisements, and most of these fall by the way.

"To sum the matter up, it is believed that any attempt at giving by the correspondence methods a really thorough education to persons who must at the same time follow their daily occupations must end in failure. Narrow and shallow courses may be regarded as the inevitable issue. It should, however, again be emphasized that in the absence of better means, and in so far as these schools are honestly conducted, they hold out opportunities to the many, and rewards to the few well worthy the effort of attainment. And, in conclusion, their highest destiny will have been achieved if by their coming they shall but quicken the birth of a system of popular education—industrial and commercial—worthy in every sense of this great nation."

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents: thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10c. per month, or $1.00 a year; to non-subscribers, 25c. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U.S.A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Journal of Science. *m.* New Haven, Conn.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Brick Builder. *m.* Boston, Mass.
Bridges. *m.* Chicago.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Electrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita, *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, U.S.A.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *w.* New York
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Journal of Worcester Pol. Inst. Worcester, Mass.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna
Ores and Metals. *w.* Denver, Colo.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Públicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, U. S. A.
Sanitary Plumber. *s-m.* New York.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, U. S. A.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston.
Terrestrial Magnetism. *qr.* Cincinnati, O.
Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
Trans. Am. Ins. Electrical Eng. *m.* w York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Western Railway Club Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, U. S. A.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Building Stone.

See Civil Engineering, Materials.

Coliseum.

Structural Work of the St. Louis Coliseum. The structural design is based upon the three-hinged arch system. Sectional plans are given and interior view. 1500 w. Eng News—Aug. 10, 1899. No. 29007.

Fire-Escape.

A Novel Fire-Escape. Illustrated description of a fire-escape consisting of a chute and spiral slide. 400 w. Sci Am—Aug. 26, 1899. No. 29179.

Fire-proofing.

Some Deductions from the Evolution in Fire-Proof Construction. Corydon T. Purdy. Historical review of the progress of this form of construction. 1800 w. Br Build—Aug., 1899. Serial. 1st part. No. 29376 C.

Floors.

Fire-Resisting Floors. Illustrates and briefly describes many forms of construction. 1400 w. Fire & Water—Aug. 5 and 12, 1899. Serial. 2 parts. No. 28969.

Foundations.

Cantiliver Foundations of an English Building. Illustrated description of the manner of supporting about half a warehouse under which runs a tunnel. 1000 w. Eng Rec—Aug. 5, 1899. No. 28926.

Opera House.

The New Building of the Comic Opera at Paris (Das Neue Gebäude der Komischen Oper in Paris). An illustrated description of this handsome new auditorium in Paris, with especial reference to the manner in which exits have been provided in case of fire. Two articles. 3000 w. Schweizerische Bauzeitung—July 15, 22, 1899. No. 29264 each B.

Roof Arch.

The Jersey City Trainshed. Illustrated description of the extension of the Jersey City trainshed for the Pennsylvania R. R., and the methods of carrying out the work, with notes on the erection of other large arch roofs. 3500 w. Eng Rec—Aug. 5, 1899. No. 28922.

Skeleton Construction.

Early Skeleton Construction. An examination of the claims of various architects for priority in the use of steel frames to carry outside walls as well as floors and partitions. 1700 w. Eng Rec Aug. 12, 1899. No. 29033.

Stable.

The L. L. Sterns Stables, New York. Illustrated description of the arrangement and fittings of an unusually large private stable and riding hall. 1900 w. Eng Rec—Aug. 19, 1899. No. 29126.

Store.

The Dufayel Department Store (Un-Palais Industriel: L'Administration Dufayel). An illustrated description of the new central building of the Dufayel system of department stores in Paris. 2000 w. Revue Technique—Aug. 10, 1899. No. 29217 D.

HEATING AND VENTILATION.

Exhaust Steam.

See Mechanical Engineering, Steam Engineering.

Gas or Steam.

Gas or Steam Heating. Comments on the labor-saving possible by the use of gas and steam for heating, quoting from articles describing their use in America. 1800 w. Jour Gas Lgt—July 25, 1899. No. 28909 A.

Hot Water.

A Hospital Hot-Water Heating Plant. Illustrated description of an unusually large plant with direct hot-water radiation and a plenum ventilation system. 1700 w. Eng Rec—Aug. 26, 1899. No. 29324.

Low Pressure Hot Water as a Heating Medium. Louis F. Pearson. Read at a meeting of the Inst. of Heat. and Ven. Engs., at Stourbridge. Compares low pressure hot water with other forms of heating apparatus, discussing the necessary qualifications of a desirable heating installation. 1500 w. Plumb & Dec—Aug. 1, 1899. No. 29027 A.

Low Pressure.

Stand Pipes for Low Pressure Heating Boilers (Die Standrohre der Niederdruck-Dampfkessel). A résumé of the statutes in force in various parts of Germany relating to the use of open standpipes for the regulation of pressure on boilers used for cooking, evaporating and similar purposes. Illustrations of various approved methods are given. Two articles. 5000 w. Gesundheits-Ingenieur—July 15, 31, 1899. No. 29253 each B.

Mill Plant.

A Mill Ventilating and Heating Plant. Illustrated description of a hot-blast plant for a large paper mill. 1000 w. Eng Rec—Aug. 12, 1899. No. 29038.

Moisture.

The Influence of Moisture in the Air upon the Health of Occupants of Closed Rooms (Die Bedeutung des Wasserdampfgehaltes der Luft für die Gesundheit der im Geschlossenem Raum sich Aufhalten den Menschen). H. C. Nussbaum. Emphasizing the importance of maintaining the proper degree of humidity in artificially warmed rooms. 2500 w. Gesundheits-Ingenieur—July 31, 1899. No. 29254 B.

Ventilation.

Upward and Downward Ventilation. An explanation of their relative advantages. 500 w. Eng Rec—Aug. 26, 1899. No. 29325.

Warming.

See Electrical Engineering, Heating.

PLUMBING AND GAS FITTING.

Cooking.

Cooking on a Large Scale (Massenkochanlagen). M. Grellert. A very full discussion of the arrangement of plants for cooking food in large quantities by steam. Two articles. 7500 w. Gesundheits-Ingenieur—July 31, Aug. 15, 1899. No. 29255 each B.

Regulations.

An Excellent Set of Plumbing Regulations. Gives the plumbing ordinance in effect at Moline, Ill. 6000 w. Dom Engng—Aug., 1899. No. 29135 C.

Sanitation.

Domestic Sanitation. W. Watkins. Read before the Sanitary Inspectors' Assn., during the Conference at Lincoln, England. Considers various appliances in household use, and the surroundings that affect the soil and healthfulness of the home. 3300 w. Builder—Aug. 12, 1899. No. 29151 A.

Soldering.

The Art of Soldering. From *The Textile Journal,* Bombay, India. Some points bearing on this subject and the materials used. 1700 w. Dom Engng—Aug. 1899. No. 29134 C.

MISCELLANY.

Lightning Protection.

The Protection of Structures from Lightning. Information from a pamphlet recently issued by the U. S. Weather Bureau bearing upon this subject. 1800 w. Eng News—Aug. 10, 1899. No. 29011.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

The Alexander III. Bridge Over the Seine (Pont Alexandre III. sur la Seine). E. Rouyer. Describing especially the methods of casting the steel voussoirs, and of assembling the arches prior to erection. 4000 w. 1 plate. Génie Civil—July 15, 1899. No. 29200 D.

Aqueduct.

The Oudan Aqueduct Bridge (Le Pont-Rivière d'Oudan). M. Mazoyer. An illustrated description of the iron aqueduct by which the Oudan is carried across Roanne-Digoin canal. 2000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29212 E + F.

Berne.

The Ironwork of the Kornhaus Bridge at Berne (Die Eisenkonstruktion der Kornhausbrücke in Bern). A very complete account of the structural work of the great arch bridge over the Aar at Berne, of 377 feet span. Three articles, 6000 w. Schweizerische Bauzeitung—July 8, 15, 22, 1899. No. 29262 each B.

Boston Bridge.

The Fort Point Channel Bridge, Boston. Illustrated description of a rolling lift bridge with three double track spans 85 to 113 feet long. 1200 w. Eng Rec—Aug. 19, 1899. No. 29119.

Counterstresses.

Insufficient Provision for Counterstresses in Railroad Bridges. Henry S. Pritchard. Presents considerations showing that provision should be made for counterstresses from some increase in the live loads, and such provision should be clearly stated in the specifications. 1500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29300 E.

Double Deck.

Double-Deck Bridge at Wells St., Chicago. Illustrated detailed description of a bridge carrying the Northwestern Elevated Ry. over the tracks of the Chicago & Northwestern Ry. 1200 w. Eng News—Aug. 24, 1899. No. 29187.

Erection.

The Erection of the Metallic Super-

structures of the Bridges over the Ciron and the Dropt (Mise en Place des Nouveaux Tabliers Métalliques des Ponts sur le Ciron et le Dropt). With a plate of details showing the construction of the false works and the manner of removing the old bridges simultaneously with the erection of the new. 1500. 1 plate. Rev Gen de Chem de Fer—July 1, 1899. No. 29234 F.

Hinged Arch.

Comparison of Weights of a Three-Hinged and a Two-Hinged Spandrel-Braced Parabolic Arch. C. W. Hudson. Results of a comparison to determine the exact relative economy as regards weight of metal as given, with a brief explanation of the method used in calculating the stresses in the two-hinged arch. Ill. 2000 w. Pro Am Soc of Civ Engs—August, 1899. No. 29301 E.

Hinged Arches for Masonry Bridges (Ponts en Maçonnerie Articulés). Especially devoted to the construction of the hinge joints to be imbedded in the masonry at the spinnings and the key of articulated arch bridges. 1200 w. Génie Civil—Aug. 12, 1899. No. 29207 D.

Theory and Calculation of the Two-Hinged Arch. Alex. Rice McKim. A mathematical treatment deriving the equations of condition and applying them to a practical example. 2800 w. Eng News—Aug. 24, 1899. No. 29186.

India.

Bridge Over the Indus. Fine illustration, with brief description, of the bridge across the Indus, on the Kotri Rohri section of the Indian State Railway. 500 w. Engng—July 28, 1899. No. 28983 A.

Launching.

The J. F. Lepine Bridge (La Pont J. F. Lepine). L. Biette. Giving a full description of the manner in which the bridge was constructed and launched over a cutting 142 feet wide, containing 11 railway tracks, without interrupting trains. 7500 w. 2 plates. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29213 E + F.

Lift Bridge.

The Scherzer Rolling Lift Bridge Over the Fort Point Channel, Boston. Illustrated description of an engineering work of interest. 800 w. R R Gaz—Aug. 4, 1899. No. 28939.

Loads.

General Criterion for Position of Loads Causing Maximum Stress in any Member of a Bridge Truss. F. C. Kunz. Discussion of paper by L. M. Haskins. 500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29307 E.

Wheel Concentrations and Fatigue Formulas in Bridge Design. Informal discussion at the annual convention, June 27, 1899. 12500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29303 E.

Niagara.

The Bridges of Niagara Gorge. Description, with illustrations of picturesque bridges which span the gorge, connecting the American and Canadian shores. 2200 w. Ill Car & Build—July 21, 1899. No. 28873 A.

The New Highway Bridge Over the Niagara River (Die Neue Strassenbrücke über den Niagara-Fluss). F. C. Kunz. A very fully illustrated account of the construction of the great Clifton arch of 840 feet span, over the Niagara river. Two articles. 1 plate. 10000 w. Zeitschr d Oesterr Ing a Arch Ver—July 28, Aug. 4, 1899. No. 29242 each B.

Plate Girders.

The Erection of Large Plate Girder Spans. Charles H. Wright. Illustrates and describes the manner of handling and the transportation of these huge masses of steel. 1500 w. Bridges—July, 1899. No. 28959 C.

Removal.

Removing a Bridge. Illustrates and describes the removal of the Chicago Terminal Transfer Bridge. 700 w. Ry Age—Aug. 18, 1899. No. 29140.

Suspension.

The Lewiston and Queenston Suspension Bridge. Illustrated description of a suspension bridge of 1,040 feet span, supported by the cables of an old demolished bridge, pieced out with eye-bars and stiffened by a truss of unusual design. 5000 w. Eng Rec—Aug. 26, 1899. No. 29319.

Viaduct.

The construction of the Viaur Viaduct (Construction du Viaduct du Viaur). M. Thery. A general description of the great steel arch over the Viaur valley, span 220 metres; with plates of the proposed and executed work. 8000 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29210 E + F.

CONSTRUCTION.

Foundations.

See Architectural Engineering, Construction.

Mountain Torrents.

Some Mountain Torrents of Switzerland. On the work necessary to defend against or regulate a torrent. Treats of cases where the water cuts away the ground on account of transverse currents, and where the torrent bed is grad-

ually deepening. Ill. 1600 w. Engr, Lond—Aug. 4, 1899. Serial. 1st part. No. 29072 A.

Pile Driver.

A Railway Pile Driver. G. W. Smith. Describes the important work done in the maintenance of bridges, and in emergencies, and describes a recently constructed pile driver for the Chicago, Milwaukee and St. Paul Railway Co. Ill. 5000 w. Jour W. Soc of Engs—June, 1899. No. 28940 D.

Reservoirs.

Covered Reservoirs at Pasadena, Cal. T. D. Allin. Illustrates and describes the work of covering the reservoirs, five being covered with flat roofs. 1600 w. Eng News—Aug. 17, 1899. No. 29101.

Retaining Wall.

The Pressure of Earth Upon a Retaining Wall (Poussée des Terres sur un Mur de Soutènement). M. Hisely. A mathematical treatment, developing a general graphical solution of the problem applicable to any character of load. 5000 w. Aun des Ponts et Chaussées—1 Trimestre, 1899. No. 29211 E + F.

Roads.

Notes on the Construction of Mountain Roads (Beitrag zur Anlage von Gebirgs-Kunststrassen). J. Rossmanith A mathematical examination of the considerations which enter into the construction of mountain highways, including questions of grade, curve and capacity. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1899. No. 29,-251 D.

Roadways Across Bogs. R. J. Howley. Describes the methods of building embankments for railways and highways across Irish bogs. 2200 w. Eng Rec—Aug. 19, 1899. No. 29121.

State Road Construction, New York. Extracts from a specification for a New York State highway, which enters into details in an unusually minute manner. 1900 w. Eng Rec—Aug. 5, 1899. No. 28923.

Subsidence.

See Mining and Metallurgy, Mining.

Transporter.

The Transporter at Bizerte, Tunis (Bizerte et son Pont Transbordeur). G. Leugny. An illustrated account of the suspension tramway ferry over the entrance to the harbour of Bizerte in Tunis. 1500 w. Revue Technique—July 25, 1899. No. 29216 D.

Tunnel.

North Bessemer Tunnel. F. E. House. Illustrates and describes the methods of construction used in the Pittsburg, Bessemer & Lake Erie Tunnel. Also discussion. 4200 w. Pro Engs Soc of W. Penn—June, 1899. No. 29385 D.

The Mersey Tunnel. Historical account of the undertaking and the difficulties encountered. 1800 w. Ill. Car & Build—July 21, 1899. No. 28872 A.

The Piercing of the Simplon. Interesting information relating to this important work, its present actual condition, etc., giving a brief review of its history and development. 1500 w. Engr, Lond—Aug. 11, 1899. No. 29162 A.

Tunneling.

The Hastings Tunneling Shield. An illustrated description of the latest form of tunneling shield, which is being used in the 20 ft. intercepting sewer at Chicago. 2000 w. Eng News—Aug. 3, 1899. No. 28933.

HYDRAULIC AND MARINE.

Breakwater.

Repairs of the Breakwater at Alderney. Bernard O'Driscoll Townshend. Presented to the British Inst. of Civ. Engs. Illustrates and describes repairs in which large concrete blocks were substituted for granite. 1200 w. Eng News—Aug. 10, 1899. No. 29010.

Canada.

Canadian Water Power and Its Electrical Product in Relation to the Undeveloped Resources of the Dominion. Thomas C. Keefer. Presidential address before the Royal Society of Canada. Attempts to give an approximate estimate of the quantity and value of the great water power available. 4000 w. Can Engr—Aug., 1899. Serial. 1st part. No. 29042.

Canals.

Mr. Hewitt on the Canals of New York. Reply of Mr. Abram S. Hewitt to the letter of inquiry sent out by the committee. Thinks there is no justification for the expenditure of any considerable sum of money for their enlargement. 1100 w. R R Gaz—Aug. 4, 1899. No. 28936.

What Had Best Be Done With the New York State Canals? A Symposium. Editorial summary of replies to the inquiry letter sent out by the expert commission appointed by the Governor, and the arguments presented. 4400 w. Eng News—Aug. 3, 1899. No. 28932.

Dam.

The Assouan Dam. Illustrations showing the progress of the irrigation works in course of construction on the Nile, with extracts from reports of en-

gineers resident on the works. 1000 w. Engr, Lond—Aug. 11, 1899. No. 29157 A.

East Jersey.

The Pumping and Power Station of the East Jersey Water Co., at Little Falls, N. J. Illustrates and describes the plant which is a combination of water and steam power, and the works connected. 2500 w. Eng News—Aug. 3, 1899. No. 28930.

Flow.

The Hele-Shaw Experiments and the Stream-Line Theory. Marston Niles. A letter discussing objections to the conclusions drawn from these experiments and pointing out what the writer considers the defects of the system. 4200 w. Engng—July 28, 1899. No. 28984 A.

Hydrography.

Recent Hydrographical Surveys. On recent work of the hydrographical department of the British Admiralty, and the great benefit accruing from this work. 2500 w. Engr, Lond—Aug. 11, 1899. No. 29156 A.

Reservoirs.

Covered Reservoirs and Their Design. Freeman C. Coffin. A brief consideration of a few types of the reservoirs of this class which have been built, a study of the elements which enter into the design and an investigation of the cost of various sizes and depths. Ill. 9500 w. Jour Assn of Engng Socs—July, 1899. No. 29377 C.

Removal of a Famous Engineering Landmark. Gives illustrations of the 42nd st. reservoir in New York city and a brief account of the scheme of which it formed a part, and its removal now in progress. 1100 w. Sci Am—Sept. 2, 1899. No. 29390.

The Conditions of Resistance of Masonry Dams for Reservoirs (Les Conditions de Résistance des Barrages des Réservoirs en Maçonnerie). M. L. Barbet. A mathematical treatment for various profiles, with diagrams showing the lines of pressure in each case. 7000 w. 1 plate. Ann des Ponts et Chaussées —1 Trimestre, 1899. No. 29209 E + F.

Water Mains.

System for Preventing the Bursting of Pipes. Describes and illustrates a recently patented system depending on the elastic cushioning of the pipes at intervals with air, by means of air domes with inclined planes, opposite the mouth of the storage dome. 1500 w. Am Mfr & Ir Wld—Aug. 24, 1899. No. 29312.

Water Power.

The Development of American Water Powers. Abstract of historical paper by John T. Fanning, giving data concerning colonial and early national hydraulic works, and explaining features of present practice. 3000 w. Eng Rec—Aug. 19, 1899. No. 29125.

Water Storage.

Application of the Principle of Water Storage to New England Rivers. J. Herbert Shedd. Slightly condensed from a paper read before the American Paper & Pulp Assn. at the New York meeting. Enumerates the advantages which have made this section of the country eminent in manufacturing, and shows the large resources yet undeveloped, and the favorable conditions for water storage. 4000 w. Eng News—Aug. 10, 1899. No. 29014.

Water Supply.

Artesian Wells for the Water Supply of Chatham and Madison, N. J. Louis L. Tribus. A description of the methods adopted and of the geological peculiarities resulting from glacial action and deposit. 900 w. Eng News—Aug. 10, 1899. No. 29012.

London (Welsh) Water Supply. R. E. Middleton. Arguments against the introduction of a water supply from Wales. Followed by discussion. 5500 w. Jour San Inst—July, 1899. No. 28971 E.

New York's Water Supply. Editorial on the project of the Ramapo Water Co. to supply 200,000,000 gals. daily from works to be designed and built in three years. Also an official statement of the work. 7800 w. Eng Rec—Aug. 26, 1899. No. 29318.

The Future Water Supply of New York City. Editorial discussion of the scheme of the Ramapo Water Co., and of other possibilities for increasing the supply. 3000 w. Eng News—Aug. 24, 1899. No. 29188.

The Water Supply of Cities. C. F. Ulrich. Read at the Columbus meeting of the Am. Water-Works Assn. Discusses the changed conditions which demand a much more liberal supply, the means of securing purity and freedom from disease germs, the advantages of large reservoirs, filtration, etc. 3200 w. Fire & Water—Aug. 12, 1899. No. 29047.

The Water Supply of the City of Glasgow. Benjamin Taylor. A beautifully illustrated article showing the construction of the great aqueduct by which the water of Loch Katrine is brought to the city of Glasgow by gravity. 4000 w. Engineering Magazine—Sept., 1899. No. 29294 B.

Water Tower.

Compton Hill Water Tower, St. Louis. Illustrated description of a standpipe 6 feet in diameter and 128 feet high, enclosed in a masonry tower about 171 feet

high. 2100 w. Eng Rec—Aug. 5, 1899. No. 28925.

Water-Works.

The Water-Works of Cambridge, Mass. Illustrated description of the recently enlarged works of the only city within the metropolitan district of Massachusetts which will not obtain a supply from the works of the Metropolitan Water Board. The paper gives descriptions of pipe line and dam details. 3000 w. Eng Rec—Aug. 26, 1899. No. 29321.

See also Civil Engineering, Municipal.

MATERIALS.

Building Stone.

Bridge Stones of the Central States. C. A. Raymond. Calls attention to the magnitude of this industry, and gives information concerning a few of the strata furnishing building or bridge stone. Ill. 3400 w. Bridges—July, 1899. No. 28958 C.

Cements.

Limes, Mortars, Cements and Concretes. Fred T. Hodgson. Information concerning these products and history of their use. The present article is devoted to the first two. 2000 w. Bridges—July, 1899. Serial. 1st part. No. 28960 C.

The Shock and the Explosion Tests of Cement. Eugene Ackermann. Translated from *Chemiker-Zeitung*. Suggestions for tests of cements to be used in fortification works. 1500 w. Stone—August, 1899. No. 29382 C.

Concrete.

Experiments to Determine the Effect of Freezing on Concrete. Walter A. Rogers. Describes tests made from which it is concluded that concrete work with cement possessing qualities similar to those tested may be carried on safely during moderately cold weather by using proper precautions. Discussion. 2500 w. Jour W Soc of Engs—June, 1899. No. 28941 D.

On the Theory of Concrete. Discussion of the paper of George W. Rafter. 9000 w. Pro Am Soc of Civ Engs—August, 1899. No. 29310 E.

Tests of Frozen Concrete. Report of experiments made by W. A. Rogers on Portland and natural cement concretes made with and without salt and kept under different temperature conditions. 1300 w. Eng Rec—Aug. 26, 1899. No. 29322.

Reinforced Cement.

Theory and Recent Applications of Reinforced Cement (Théorie et Applications Nouvelles du Ciment Armé). Harel de la Noë. A general discussion of the application of the elastic theory to structures of metal imbedded in concrete, with especial reference to the work of the writer at Le Mans. 5000 w. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29208 E + F.

Tanks.

Steel vs. Wood Tanks. Theodore W. Snow. Considers the class and durability of material and the cost, considering the wood tank better able to withstand neglect than the iron tank. Discussion, correspondence and illustrations. 7500 w. Jour W Soc of Engs—June, 1899. No. 28942 D.

Timber.

Preservation of Timber. Samuel M. Rowe. Reviews facts gained by study, experience and observation, and the processes used. 2300 w. Jour W Soc of Engs—June, 1899. No. 28943 D.

MEASUREMENT.

Field Notes.

Field Notes of a Civil Engineer—Do They Belong to His Client or to Himself? J. Vander Hoek. A discussion of this subject giving cases as illustrating certain points. 8000 w. Jour Assn of Engng Socs—July, 1899. No. 29378 C.

Micrometer.

A New Optical Distance-Measuring Device (Ein Neuer Optischer Distanzmesser.) A. Tichy. A description of the quadruple micrometer of Tichy and Starke, a form of micrometer for use in the telescope for measuring distances on the principle of the stadia system. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 1899. No. 29240 B.

MUNICIPAL.

Garbage Cremation.

Refuse Furnaces. George Watson. Abstract of a paper before the Institution of Civil Engineers, England, on the practical features of managing cremators. 2500 w. Eng Rec—Aug. 26, 1899. No. 29323.

Havana, Cuba.

The Sanitary Condition and Requirements of Havana, Cuba. E. Sherman Gould. Describes the natural conditions due to site, soil, climate, etc., and the artificial conditions created by the inhabitants, the work since the American occupation, and the permanent work needed. 2500 w. Eng News—Aug. 3, 1899. No. 28931.

Municipal Ownership.

Municipal Ownership of Water-Works. John B. Heim. States the results at

Madison, Wis., showing the advantage when they can be placed on a business basis. 1500 w. Munic Engng—August, 1899. No. 28897 C.

The Prohibition of Municipal Ownership of Michigan Street Railways. A statement of the reasons for the constitutional prohibition of the municipal ownership of street railways in the State. 1900 w. Eng Rec—Aug. 5, 1899. No. 28921.

Paris.

The Present Condition of the Sanitation of Paris (Etat Actuel de l'Assainissement de Paris). With map and profile showing the extent and nature of the sewerage improvements executed from 1895 to 1899. 2000 w. Génie Civil—July 22, 1899. No. 29202 D.

Pavements.

Notes on Indianapolis Pavements. Gives the experience with brick, wood and asphalt pavements. 1000 w. Eng Rec—Aug. 5, 1899. No. 28924.

Repairs to Asphalt Pavements. A decision of the U. S. Circuit Court of Appeals concerning various methods of repairing asphalt pavements involving the heating of the old surface and the substitution of fresh material for old. 1800 w. Eng Rec—Aug. 19, 1899. No. 29122.

Porto Rico.

Sanitary Work in Porto Rico. L. P. Davison. Describes the conditions existing and the work in progress. 1800 w. Sci Am Sup—Aug. 26, 1899. No. 29182.

Refuse Disposal.

Refuse Disposal and the Results Obtained from a Six Months' Working of the Refuse Destructor at Torquay. Henry A. Garrett. Read before the Inst. of Mech. Engrs., England. A record of the writer's experience at Torquay, with attention to important points in connection with refuse disposal. 2500 w. Engng—Aug. 18, 1899. No. 29361 A.

Septic Tank.

The Septic Tank of the Champaign Sewerage System. Arthur N. Talbot. Explains the process and the conditions under which the tank named is operated. Also editorial on "The Proper Size for Septic Sewage Tanks." 4500 w. Eng News—Aug. 17, 1899. No. 29103.

Sewage Disposal.

Baltimore Sewerage. A review of the final recommendations of a commission appointed to consider the sewerage and sewage disposal of Baltimore, where the oyster interests seriously interfere with usual practice. 1100 w. Eng Rec—Aug. 26, 1899. No. 29320.

Irrigation with Paris Sewage. A notice of the unusually high rate of irrigation per acre which must be adopted for a portion of the sewage farms in order to comply with the law. 900 w. Eng Rec—Aug. 5, 1899. No. 28920.

The Present Condition of Sewage Disposal at Paris. An outline of the progress since 1895, in the works executed for diverting the sewage of Paris from the River Seine. 1000 w. Eng News—Aug. 17, 1899. No. 29104.

Sewerage.

The Influence of Sewage on Cement. A résumé of experiments made at Lehigh University. 1100 w. Eng Rec—Aug. 19, 1899. No. 29124.

The Sewerage of Concord, Mass. Illustrated description of work involving a circular vaulted reservoir of peculiar construction, constructed with much difficulty. 1000 w. Eng Rec—Aug. 19, 1899. No. 29123.

Sewer Air.

Sewer Air: Mistaken Ideas Regarding It. Leonard P. Kinnicutt. Discusses the chemical composition and what is known of the micro-organisms, and claims there is little danger from the amount that ever enters dwellings. 3200 w. Munic Engng—August, 1899. No. 28896 C.

Sewers.

The Intercepting Sewers of Chicago. Describes the work done to keep sewage from Lake Michigan, and illustrates a novel form of shield used on one of the tunnels. 3000 w. Eng Rec—Aug. 12, 1899. No. 29035.

Town Plan.

The Project of a Residence Colony on the Cobenze Property (Das Project einer Villencolonie auf der Gutsbesitzung Cobenze). Karl Mayreder. An account of the extensive plans for laying out a residence park in the vicinity of Vienna. 4500 w. 1 plate. Zeitschr d Oesterr Ing w Arch Ver—July 14, 1899. No. 29239 B.

Stream Contamination.

Stream Contamination and Sewage Purification. Informal discussion at the annual convention, June 28, 1899. 13500 w. Pro Am Soc of Civ Engs—August, 1899. No. 29304 E.

Water Consumption.

The Consumption of Water per Head in Different Towns. Discusses the causes of the great variation, the need of regulations, and of proper measuring apparatus. 1800 w. Jour Gas Lgt—Aug. 8, 1899. No. 29093 A.

Water Supply.

See Civil Engineering, Hydraulic.

Water Works.

The Appraisal of the Gloucester Water-Works. A review of the principles adopted by the commissioners appointed to bear testimony and appraise the value of a private water company. 1700 w. Eng Rec—Aug. 19, 1899. No. 29120.

MISCELLANY.

China.

America, England and Germany as Allies for the Open Door. John Barrett. A full review of existing conditions with regard to the development of engineering and commercial advancement in the Far East, showing the identity of interests of the three Powers, and the need of immediate action for the preservation of the vast markets which it is equally to the interests of all to maintain in their entirety. 4000 w. Engineering Magazine—September, 1899. No. 29290 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The Cairo-Cape Telegraph. An illustrated account of the building of the lines of the African Trans-Continental Telegraph Company. 1500 w. Elec Rev, N. Y.—Aug. 16, 1899. No. 29086.

Coherers.

See Electrical Engineering, Electro-Physics.

Fire Alarms.

What Are the Increased Benefits of the Storage Battery for Fire Alarm Systems? Morris W. Mead. Read at the Syracuse, N. Y., meeting of the International Assn. of Fire Engineers. Considers the advantage of the storage battery over the gravity or other primary cell, and the storage battery controlling board and its special adaptation to fire telegraph service. 1200 w. Fire & Water—Aug. 26, 1899. No. 29326.

Protection.

Protection of Telephone Apparatus. H. P. Clausen. Discussion of the false notions held as to the proper conditions under which telephone apparatus should be provided with protective devices. Ill. 1800 w. Elec Engng—August, 1899. Serial. 1st part. No. 29117.

Space Telegraphy.

Telegraphy by Means of the Electric Light. Brief explanation of the system patented by Carl Zickler. 700 w. Elec, Lond—Aug. 11, 1899. No. 29145 A.

Wireless Telegraphy. Jas. L. Adams, Jr. Describes experiments made and the effects produced. Ill. 1500 w. Elec World—Aug. 19, 1899. No. 29092.

Telephones.

Automatic Telephone Exchange at Augusta, Ga. Lee Campbell. An illustrated description of the Augusta system. 1500 w. Elec Wld—Aug. 26, 1899. No. 29313.

Automatic Telephones of the German Post Office (Die Fernsprechautomaten der Reichs-Postverwaltung). A description with details of the slot-controlled telephones used by the German post-office. 2000 w. Eektrotech Zeitschr—Aug. 3, 1899. No. 29273 B.

Richmond Home Telephone Company. A. E. Dobbs. An illustrated description of the fine construction at Richmond, Ind. The system adopted is that of complete metallic service to each subscriber. 1800 w. Elec Engng—August, 1899. No. 29118.

Transmitting.

Methods of Transmitting Intelligence. George D. Shepardson. Interesting account of the development of methods for near or remote points. 5500 w. Elec Rev, N. Y.—Aug. 2, 1899. No. 28907.

DISTRIBUTION.

Charges.

On the Determination of a Fair Return for Current Supply. C. W. Hutton. Read before the Pacific Coast Elec. Trans. Assn. Suggestions of a method for establishing a rate based on the length of time a customer uses the current. 3300 w. Jour of Elec—July, 1899. No. 29041.

Switchboards.

The Construction of Switchboards. William Baxter, Jr. Discusses the arrangements of switchboards designed for plants of large capacity. Ill. 1600 w. Am Mach—Aug. 24, 1899. Serial. 1st part. No. 29193.

The General Arrangement and Connection of Apparatus on Switchboards. William Baxter, Jr. Explains the general arrangement of the switches, instruments and other apparatus, showing how they are connected with each other and with the generators and the external circuits. Ill. 1700 w. Am Mach—Aug. 10, 1899. Serial. 1st part. No. 29020.

Wiring.

Concentric Wiring. Mervyn O'Gor-

man. Illustrates this system of wiring and sets forth its advantages. 3000 w. Elec Wld & Elec Engr—Aug. 12, 1899. No. 29016.

Works Distribution.

Electric Power Distribution in a German Workshop. O. Lasche, in *Zeitschrift des Vereins Deutscher Ingenieure.* Abstract translation, with illustrations, describing the power distribution of the Allgemeine Elektricitäts Gesellschaft. and also individual driving. 1700 w. Elect'n, Lond—July 21, 1899. No. 28-868 A.

ELECTRO-CHEMISTRY.

Battery.

Historical Notes on the Primary Battery. W. R. Cooper. From a book to be published by *The Electrician* Printing and Publishing Co. Gives the early history and development. 1200 w. Elect'n, Lond—Aug. 18, 1899. No. 29345 A.

Calcium Carbide.

Three-Phase Currents in the Manufacture of Calcium Carbide in Italy. Cesare Pio. Gives data relating to the construction and operation of the furnaces in which three-phase currents are used, the production and cost. Ill. 3000 w. Elec Wld & Elec Engr—Aug. 5, 1899. No. 28934.

See also Gas Engineering.

Desilverizing.

The Cost of the Electrolytic Desilverization of Argentic Lead (Prix de Revient de la Désargentation Electrolytique des Plombs Argentifères). A detailed examination of the Tommasi process, showing the various items of cost, and deducing the total cost to be about 7 francs per ton of lead treated. 1500 w. Electricièn—June 17, 1899. No. 29265 B.

Electrolysis.

The Electrolytic Separation of Lean Gold-Silver Alloys (Ueber die Elektrolytische Scheidung Armen Güldischen Silbers). Dr. A. Dietzel. A paper read before the German Electrochemical Society, giving details of an apparatus and method for separating small proportions of gold from silver alloys. 2000 w. Zeitschr f Elektrochemie—July 27, 1899. No. 29278 G.

Progress.

The Progress of Electro-Chemistry in 1898. H. Borus. Begins a review of the work accomplished by various investigators. 3000 w. Eng & Min Jour—Aug. 12, 1899. Serial. 1st part. No. 29031.

Statistics.

The Future of Electrochemical Technology (Ueber den Gegenwärtigen Stand der Elektrochemischen Technik). Prof. H. Borchers. A paper before the German Electrochemical Society giving very full statistics of present and proposed electrochemical works in various parts of the world, with discussion. 6000 w. Zeitschr f Elektrochemie—July 20, 1899. No. 29277 G.

ELECTRO-PHYSICS.

Carbon.

The Energy of Carbon. C. J. Reed. Pure carbon alone is considered, and a study is made of the possibilities and limitations in transformnig the energy of carbon into available forms of energy. 2100 w. Elec Wld & Elec Engr—Aug. 12, 1899. Serial. 1st part. No. 29017.

Coherers.

A Self-Recovering Coherer and the Study of the Cohering Action of Different Metals. J. Chunder Bose. Read before the Royal Soc. Account of researches on the cohering properties of various metals when exposed to electric radiation. 4000 w. Elect'n, Lond—July 21, 1899. No. 28869 A.

Conductivity.

The Dielectric Cohesion of Rarefied Gases (Sur la Cohesion Diélectrique des Gaz Raréfiés). E. Bonty. A further communication to the French Academy, describing the author's experiments with electric currents in exhausted tubes. 1200 w. Comptes Rendus—July 24, 1899. No. 29225 D.

The Electrolytic Conductivity of Rarefied Gases (Les Gaz Raréfiés Possedent-ils la Conductivité Electrolytique?). E. Bonty. A communication to the French Academy, giving the results of experiments with Crookes' and Geissler's tubes. 1500 w. Comptes Rendus—July 17, 1899. No. 29222 D.

Interrupter.

Concerning Wave Currents (Ueber Wellenströme). Dr. C. Heinke. A discussion of the "wave," or intermittent current in connection with experiments upon the Wehnelt interrupter. Two articles. 10000 w. Electrotech Zeitschr—July 20, 27, 1899. No. 29269 each B.

The Wehnelt Current-Interrupter (Der Elektrolytische Stromunterbrecher). Von Dr. A. Wehnelt. A description of the Wehnelt apparatus, especially in connection with the induction coil for the purpose of radiography. 2500 w. Elektrochemische Zeitschr—July, 1899. No. 29280 G.

Magnetism.

Magnetism and Molecular Rotation. Lord Kelvin. Paper, editorial and correspondence. 4500 w. Elect'n. Lond—Aug. 4, 1899. No. 29065 A.

The Magnetic Field in the Interior of a Hollow Cylinder Traversed by a Current (Sur le Champ Magnétique à l'Interieur d'un Cylindre Creux Parcouru par un Courant). W. de Nikolaieve. A short communication to the French Academy showing the author's demonstration of the existence of a magnetic couple in the interior of a tubular current. 600 w. Comptes Rendus—July 24, 1899. No. 29224 D.

Phillips Phenomenon.

A Mathematical Investigation of the Phillips Phenomenon. George W. Walker. States briefly the experiment and gives a general explanation, and the mathematical treatment of the question. 1400 w. Elect'n, Lond—Aug. 18, 1899. Serial. 1st part. No. 29346 A.

Resistance.

On the Electrical Resistivity of Mixtures of Plumbago and Clay. J. A. Fleming. Reports experiments by which the author found that by varying the proportions of clay and blacklead any required resistivity could be produced within very wide limits. 1800 w. Elect'n, Lond—July 28, 1899. No. 28980 A.

Salt Vapors.

The Electrical Conductivity of Flames Containing Salt Vapors. Harold A. Wilson. Abstract of a paper read before the Royal Soc. Describes experiments undertaken following up the analogy between the conductivity of salt vapors and Rontgenized gases, and getting some information about the velocity of the ions in the flame itself. 1200 w. Elect'n, Lond—July 21, 1899. No. 28870 A.

GENERATING STATIONS.

Accounts.

Corporation Electricity Works Accounts. H. M. Stevens. Read at the Corporate Treasurers' and Accountants' Institute, England. A discussion of some points in the form prescribed by the Board of Trade. 3500 w. Elect'n, Lond—Aug. 11, 1899. No. 29148 A.

Accumulators.

The Accumulator Tests of the Automobile Club of Paris (Concours d'Accumulateurs de l'Automobile Club de Franee). A. Bainville. The beginning of a review of the various accumulators tested, with a description of the manner of making the trials. Serial. Part 1. 1000 w. L'Electriciën—June 24, 1899. No. 29267 B.

Alternators.

The Alterations to the Brush Alternators at Bankside Station. Ernest Kilburn Scott. Describes alterations made to the alternators at this London electric-lighting station. Ill. 1200 w. Elect'n, Lond—Aug. 18, 1899. No. 29344 A.

Barrow-in-Furness.

Barrow-in-Furness Electricity Works. Illustrated description, with information concerning this seaport town of 60,000 inhabitants. The system of supply adopted is the high-tension, continuous-current generation, with motor-transformers. 4500 w. Elec Engr, Lond—Aug. 4, 1899. No. 29063 A.

Direct Connection.

A 2000-H. P. Tri-Compound Engine Direct Connected to a 10,000-Volt Ferranti Generator. Describes a novel design of steam engine in operation at Deptford, Eng., at the works of the London Electric Supply Corporation. 600 w. Eng News—Aug. 10, 1899. No. 29009.

Exhaust Steam.

See Mechanical Engineering, Steam Engineering.

Isolated Plants.

Saving in Isolated Plants. Alton D. Adams. Estimates of cost are discussed, and the difference in cost between light from isolated plants and public supply. 1400 w. Sci Am—Aug. 19, 1899. No. 29087.

Leith, Scotland.

Leith Corporation Electric Supply Works. Illustrates and describes a successful station completed in very short time. 2200 w. Elect'n, Lond—Aug. 11, 1899. No. 29147 A.

Louisville Station.

The Central Station of the Louisville Electric Light Co. George Wilbur Hubley. A description, with illustrations, of a comprehensive system generating alternating, 500-volt power and series arc current. 4300 w. Am Elect'n—August, 1899. No. 28860.

Mine Plant.

Electrical Installation in Coal Mines. Harry N. Gardner. Comments on the conditions and causes that have deterred operators from installing electric plants, and describes work that has been efficient and profitable. Ill. 2500 w. Am Elect'n—August, 1899. No. 28861.

The La Bella Mill Water and Power Company's Plant. Describes a plant in the Cripple Creek region of Colorado for running railways and operating hoists, pumps, compressors, etc., in mines. 2000 w. Elec Rev, N. Y.—Aug. 23, 1899. No. 29172.

Piping.

See Mechanical Engineering, Steam Engineering.

Pittsburg.

See Street and Electric Tramways.

Plymouth, Eng.

Plymouth Electric Supply Works. An illustrated account of recently completed works, the first in England to combine the running of the tramways and the lighting of the town. 3700 w. Engng—July 21, 1899. No. 28877 A.

Portable Plant.

A Portable Generating Plant (Wagon Porteur d'un Groupe Electrogène). Brief description of a car containing boiler, engine and electric generator, the whole adapted to be hauled to any point on the tracks of a railway system. 500 w. 1 plate. Génie Civil—Aug. 12, 1899. No. 29206 D.

Sparking.

Experiments Upon a Continuous Current Generator With Two Independent Windings (Versuche an einer Gleichstrommaschine mit zwei unabhängigen Wickelungen). A. Sengel. A discussion of experiments with independent windings and a third brush to avoid sparking in a continuous current dynamo. Two articles. 6000 w. Elektrotech Zeitschr—July 27, Aug. 3, 1899. No. 29270 each B.

St. Helens.

St. Helens Corporation Electricity Works and Tramways. Illustrated detailed account. 5300 w. Elec Rev, Lond—July 21, 1899. No. 28874 A.

Stockholm.

Stockholm Central Station. An illustrated account of a station belonging to the municipality, with table showing its progress. 1100 w. Elec Eng, Lond—Aug. 11, 1899. No. 29149 A.

West Ham.

West Ham Corporation Electric Supply Works. Illustrates and describes the plant. The system of supply is the single-phase alternate-current system, with transformer sub-stations. 2500 w. Elect'n, Lond—Aug. 4, 1899. No. 29064 A.

HEATING AND WELDING.

Rail-Welding.

Electric Rail-Welding at Buffalo. Illustrates and describes a plant of the Lorain Steel Co. in operation in this city where 50 miles of track is being welded. 900 w. Elec Wld & Elec Engr—Aug. 12, 1899. No. 29019.

Warming by Electricity (Le Chauffage par l'Electricité). A. Bainville. A general review of the progress which has been made in warming by electricity, describing various forms of apparatus, and indicating the probable development. 1800 w. L'Electricien—July 15, 1899. No. 29266 B.

Warming.

Electric Heating in a Carmelite Hospice. Illustrates and describes an interesting installation receiving its power from the Canadian Niagara Power Co. 1100 w. Sci Am—Aug. 5, 1899. No. 28917.

LIGHTING.

Arc Lights.

Cost of Light from the Electric Arc. Alton D. Adams. An analysis of costs for enclosed and open arc lamps, with the prediction that the high tension, open arc, will soon be displaced by the enclosed arc from constant pressure mains. 1700 w. Munic Engng—Aug., 1899. No. 28895 C.

Efficiency.

The Proper Efficiency of Incandescent Lamps for Central Stations, Including a Description of the Nernst Lamp. E. E. Cary. Read before the Canadian Elec. Assn. A table of the efficiency and average life of lamps at various voltages is given and discussed, with consideration of some of the difficulties in the operation of the Nernst lamp. 3000 w. Can Engr—Aug., 1899. No. 29044.

Electricity vs. Gas.

Electric Lighting versus Gas. John Martin. Read before the Pacific Coast Elec. Trans. Assn. Considers the two methods of illumination with a view to determining the proper rates. 2400 w. Jour of Elec—July, 1899. No. 29040.

Enclosed Arc.

Long Burning Enclosed Arc Lamps. William A. Turbayue. From a paper read before the Canadian Elec. Assn. Traces the improvements which led to the development of the long burning lamp, which has a life of 150 hours or more, the economies and other advantages. 2000 w. Can Engr—Aug., 1899. No. 29043.

Illumination.

See Gas Engineering.

MEASUREMENT.

Alternating Currents.

A Simple and General Method of Obtaining the Mean Value of the Power of an Alternating Current. Samuel J. Barnett. Mathematical demonstration. Also reprint of previous paper in which several typographical errors appeared. 1800 w. Elec Wld—Aug. 26, 1899. No. 29315.

A Simple Device for Measuring the Frequency of an Alternating Current. Hubert V. Carpenter. Describes a

method in which a stretched wire vibrates in synchronism with the current. 1800 w. Elec Wld & Elec Engr—Aug. 5, 1899. No. 28935.

Current Strength.

On the Determination of Current Strength in Three-Pointed Star Resistance Systems. A. E. Kennelly. Explains a manner of computing these current strengths, and of producing two-phase currents from a three-phase system and *vice versa*. 2000 w. Elec Wld—Aug. 19, 1899. No. 29090.

Galvanometer.

The Theory of the Tangent Galvanometer and its Modifications. J. Warren. Part first explains the instrument and the manner of determining the angle of maximum sensitiveness. 1200 w. Elec, Lond—Aug. 11, 1899. Serial. 2 parts. No. 29144 each A.

Polyphase Systems.

Measurement of Power in Polyphase Systems. Aug. J. Bowie, Jr. Considers the cases of unbalanced and balanced loads usually encountered in practice. 1500 w. Elec Wld—Aug. 19, 1899. No. 29091.

POWER APPLICATIONS.

Canal Traction.

Experiments Upon the Lamb and the Köttgen Systems of Electric Towing (Elektrische Schleppschiffahrtsversuche mit dem System Lamb und dem System Köttgen). G. Klingenberg. With a number of illustrations showing the practical applications of the two systems on the Finow Canal. 7000 w. Elektrotech Zeitschr—Aug. 3, 1899. No. 29272 B.

Crane.

Electric Traveling Crane of 35 Tons Capacity (Elektrisch Betriebener Laufkran von 35 t Tragkraft). Paul Uellner. An illustrated description with numerous details, of a powerful crane recently constructed by the *Compagnie Internationale* d'Electricité, of Liége. 2500 w. Zeitsch d Ver Deutscher Ing—July 15, 1899. No. 29243 D.

Electric Locomotives.

See Railway Affairs, Motive Power.

Electrical Protection.

Electrical Protection of Safes and Vaults. Clyde J. Coleman. Read before the Chicago Elec. Assn. Reviews various means for protection that are in use or have been suggested, and the considerations to be met in providing an effective system. 1800 w. Sci Am Sup—Aug. 19, 1899. No. 29089.

Hat Works.

Electricity in Hat Manufacture. Illustrates and describes an installation for furnishing heat, light and power for use in the manufacture of hats. 1800 w. W Elect'n—Aug. 12, 1899. No. 29046.

Machine Driving.

The Form and Speed of Electric Motors Direct Connected to Machines. Alton D. Adams. Considers the possibility of making the motor a symmetrical part of the driven machine, the relation of speed of motor to the work, etc. Ill. 1000 w. Eng News—Aug. 10, 1899. No. 29008.

Mine Power.

Electricity in the Mines at Cripple Creek. Thomas Tonge. With many illustrations showing the wide range of applications of electricity for power in mining operations, as experienced in the gold mines of Colorado. 3500 w. Engineering Magazine—Sept., 1899. No. 29295 B.

Pantagraph.

An Electric Pantagraph. F. Jarvis Patten. Illustrates and describes the device and its use. 1400 w. Elec Wld & Elec Engr—Aug. 12, 1899. No. 29018.

Electric Engraving Machine. F. Jarvis Patten. Illustrates and describes a valuable application of the pantagraph, which seems destined to make machine engraving in wood or metal a reliable process at great speed and small cost. 1600 w. Elec Wld—Aug. 26, 1899. No. 29316.

Plow.

An Electric Motor Plow (Ein Elektrischer Motorpflug). Dr. E. Müllendorx. A very complete description of a system using electric power to haul gang plows back and forth. Two articles. 6000 w. Glaser's Annalen—Aug. 1, 15, 1899. No. 29250 each D.

Pumps.

Electrically-Driven Centrifugal Pumps. Lewis A. Hicks. Read before the Pacific Coast Electric Transmission Assn. Describes experiments made by the Kern County Land Co., and methods of investigating centrifugal pumps. Ill. 5000 w. Jour of Elec—July, 1899. No. 29039.

Wagon Works.

Electrical Equipment in Fish Bros.' Wagon Factory. Illustrates and describes the equipment of an extensive factory in Racine, Wis. 1800 w. W Elect'n—Aug. 26, 1899. No. 29330.

Works Distribution.

See Electrical Engineering, Distribution.

TRANSMISSION.

Conductors.

Aluminum vs. Copper. Charles T. Child. A comparison of the relative values of the two metals for electrical uses, showing aluminum to be the cheaper metal of the two at the present prices. 1100 w. Elec Rev, N. Y.—Aug. 30, 1899. No. 29386.

Insulation.

The Use of Insulated Cables for Strong and Weak Currents (Isolirte Kabel für Stark und Schwachstrom und ihre Herstellung). G. Zapf. A paper before the Electrotechnic Society of Cologne, discussing cables for telephone and other electrical conductors. 5000 w. Elektrotech Zeitschr—Aug. 10, 1899. No. 29275 B.

Regulations.

Safety Regulations for Electric Currents of Medium Voltage (Sicherheitsvorschriften für Elektrische Mittelspannungs-Anlagen). A full reprint of the regulations formulated by the Society of German Elektrotechnicians. 6000 w. Elektrotech Zeitschr—Aug. 10, 1899. No. 29274 B.

MISCELLANY.

Accidents.

The Physiological Properties of Electricity (Propriétés Physiologiques de l'Electricité). Dr. F. Mally. With especial reference to accidents in connection with the industrial applications of electricity, and instructions as to the aid of the injured. Two articles. 5000 w. Génie Civil—July 29, Aug. 5, 1899. No. 29204 each D.

Tanning.

Electric Tanning. Concerning a process, devised by Dr. L. A. Groth, which he claims shortens the period to about one-fifth the previous time and affects a saving of about 30 per cent. 900 w. Ind & Ir—Aug. 4, 1899. No. 29068 A.

Volta Centenary.

The Volta Centenary. Giulio Martinez. Notes and illustration concerning the exposition at Como, which was destroyed by fire. 900 w. Elec Wld—Aug. 26, 1899. No. 29317.

Some Notes on the Electrical Machinery at the Como Exhibition. Kenelm Edgcumbe. 1500 w. Elec Rev, Lond—Aug. 18, 1899. Serial. 1st part. No. 29342 A.

GAS ENGINEERING

Acetylene.

A New Acetylene Generator. From *La Nature*. An illustrated description of a new apparatus called the "Bruncor." 700 w. Sci Am Sup—Aug. 26, 1899. No. 29183.

The Acetylene Exhibition and Congress at Budapest. An account of the meeting, with abstracts of important papers and comments. 3000 w. Engr, Lond—Aug. 11, 1899. No. 29168 A.

Ammonia.

The Utility of Sulphate of Ammonia in Agriculture. James Muir. Explains the manner of action of sulphate of ammonia, showing how it may best be used on the various crops of the farm with a view to profit. 6400 w. Jour Gas Lgt—July 18, 1899. Serial. 1st part. No. 28854 A.

Bye-Products.

Gas Purification with Recovery of Bye-Products. Dr. J. Bueb. Abstract translation of a paper read at a recent meeting of the German Assn. of Gas and Water Engs. A paper of much interest, with editorial. 5000 w. Jour Gas Lgt—Aug. 1, 1899. No. 29024 A.

Gas Purification, with Recovery of Bye-Products. The discussion on Dr. Bueb's paper. 2200 w. Jour Gas Lgt—Aug. 8, 1899. No. 29094 A.

Carbide.

The Cost of a Ton of Calcium Carbide for Different Sources of Power (Herstellungskosten von 1000 kg. Calcium Carbid bei Verschiedenen Betriebskraften). F. Liebetanz. A paper read before the Acetylene Congress at Budapest, showing the influence of the cost of power upon the cost of carbide. 3000 w. Zeitschr f Elektrochemie—Aug. 10, 1899. No. 29279 G.

See Also Electrical Engineering, Electro Chemistry.

Coke-Oven Gas.

See Mining and Metallurgy, Coal and Coke.

Electrolysis.

Electrolytic Trials. William A. Aldrich. Read before the Pacific Coast Gas Assn. An explanation of the action and its destroying effect on iron pipes, giving the troubles in various cities. Discussion. Ill. 7000 w. Am Gas Lgt Jour—Aug. 14, 1899. No. 29051.

Exhausters.

Gas Exhausters and Gas Exhausting Plant. R. Hargraves. Condensed paper read before the Manchester Assn.

of Engs. Shows that the most up-to-date plant for exhausting coal gas is behind good engineering practice of the present day. 2200 w. Gas Engs' Mag —Aug. 10, 1899. No. 29311 A.

Fuel Gas.

Fuel Gas. C. Francis Jenkins. On the change gas manufacture is undergoing, adapting it to wider uses. Ill. 1000 w. Sci Am—Aug. 12, 1899. No. 28996.

The Fuel Question in California. John L. Howard. Read before the Pacific Coast Gas Assn. Considers the causes that make this state draw a greater variety of coals from more sources than any other country; discusses the progress being made by gas fuel; the use of oil for steam generation; and of electricity from water power. Discussion. 6500 w. Am Gas Lgt Jour —Aug. 14, 1899. No. 29050.

Furnace Gas.

Blast-Furnace Gas for Motive Power. W. H. Booth. An account of experiments with the Thwaite apparatus, with suggestions for the treatment of American gas. 2500 w. Mod Mach—Aug., 1899. No. 28957.

The Actual State of the Question of Gas Engines Operated by Furnace Gas (Etat Actuel de la Question des Moteurs à Gaz de Haut-Fourneau). H. Savage. A review of the experiences which have been had in the use of furnace gases in motors in Belgium, Germany and Scotland, showing that the matter has passed the experimental stage. 4000 w. Rev Univ des Mines—July, 1899. No. 29227 G.

The Utilization of Blast Furnace Gases (Zur Ausnutzung der Hochofengase). F. Zeyringer. A discussion of the chemical and thermal questions involved in the production and utilization of furnace gases in internal combustion motors. 2000 w. Stahl und Eisen—July 15, 1899. No. 29258 D.

Utilizing Charcoal Blast-Furnace Gases. F. Zeyringer. Abstract of article in *Stahl und Eisen*. Enumerates the factors which determine the constitution and quantity of the waste gases, and describes a set of furnaces worked with charcoal fuel. 1200 w. Eng & Min Jour —Aug. 12, 1899. No. 29030.

Gas Calculations.

"27.68." Henry O'Connor. An explanation of the usefulness of these figures in various problems of gas engineering. 1200 w. Jour Gas Lgt—Aug. 15, 1899. No. 29174 A.

Gas Compressor.

Intensified Gas Lighting, With and Without Water Power. James Keith. Abstract of paper presented at Stirling meeting of the North British Assn. Describes Keith's automatic air and gas compressors and explains their advantages. Ill. 1500 w. Gas Wld—July 29, 1899. No. 28976 A.

Gas Power.

See Street and Electric Tramways.

Gas Works.

Notes on Building Construction in Small Gas Works. S. B. Langlands. Read before the North of Ireland Assn. of Gas Mgrs. Calls attention to points of construction and states the writer's views concerning the advantages of certain treatments. 2400 w. Gas Wld—Aug. 19, 1899. No. 29341 A.

Illumination.

Artificial Illumination for Ordinary Business and Domestic Purposes. Leon P. Lowe. Read at meeting of the Pacific Coast Gas Assn. A comparison of the illuminating power and cost of gas light, Welsbach light, electric incandescent, and acetylene gas. 2200 w. Am Gas Lgt Jour—Aug. 7, 1899. No. 28970.

Artificial Light, With Special Reference to Gas and Electricity. A. Yuill. Read at the Stirling meeting of the North British Assn. Reviews early methods of producing light, and the history of the gas industry, comparing gas and electricity. Discussion. 4500 w. Gas Wld—July 29, 1899. No. 28974 A.

Intensive Lighting. M. A. Lecomte. Summary of a paper read before the Société Technique du Gaz en France. On the means of producing intensive lighting; the burners, chimneys, mantles, etc. Ill. 5000 w. Gas Wld—Aug. 5, 1899. No. 29060 A.

Mantles.

On Incandescent Mantles; Effects of Various Oxides. W. Bruno. Translated and abstracted from the *Zeitschrift für Beleuchtungswesen*. Gives results of a long series of experiments in hardening the mantles, with discussion of the action of ceria. 2500 w. Gas Wld—Aug. 19, 1899. No. 29340 A.

Photometer.

An Improved Form of Portable Photometer. Illustrates and describes a simple and reliable instrument. 500 w. Eng News—Aug. 10, 1899. No. 29013.

Prices.

In Favor of Differential Prices for Gas. R. B. Anderson. Read before the North of Ireland Assn. of Gas Mgrs. Advocates the adoption of differential rates where the prices are high. Discussion. 7500 w. Gas Wld—Aug. 12, 1899. No. 29339 A.

Purification.

Further Observations on Purification. S. Carpenter. Suggestions relating to the purification of gas from sulphur. 2800 w. Jour Gas Lgt—July 25, 1899. No. 28910 A.

Rates.

Differential Rates as Between Consumers of Gas for Lighting and for Purposes other Than Lighting. A paper called out by the statements made by Thomas Newbigging. 2500 w. Jour Gas Lgt—Aug. 22, 1899. Serial. 1st part. No. 29391 A.

Retorts.

The Working of a Semi-Regenerative Setting. W. A. Reid. Describes work of the writer, and gives brief discussion. 1800 w. Jour Gas Lgt—Aug. 15, 1899. No. 29177 A.

Self-Ignition.

Self-Ignition, Far and Near. On the interesting installation recently made at the Waterloo Station of the South-Western Railway, England. 1300 w. Jour Gas Lgt—Aug. 1, 1899. No. 29025 A.

The Automatic Ignition of Gas by Chemical Means. J. B. Grimwood. On igniters depending for action upon the property of certain metals to absorb gases. Discussion. 5000 w. Am Gas Lgt Jour—Aug. 21, 1899. No. 29143.

Testing.

On the Continuous Mode of Testing Gas. C. R. C. Tichborne. Read before the North of Ireland Assn. of Gas Managers. Describes in detail a process for estimating ammonia. 1600 w. Jour Gas Lgt—Aug. 15 ,1899. No. 29175 A.

Water Gas.

Carburetted Water Gas. Ivison Macadam. Lecture delivered at the Stirling meeting of the North British Assn. Describes the plant used and its working. Discussion. 3300 w. Gas Wld—July 29, 1899. No. 28975 A.

MARINE AND NAVAL ENGINEERING

Anti-Fouling.

The Dangers of the Use of Metallic Copper in Anti-Fouling Compositions. Reviews the various attempts made to protect the hulls of vessels, and the trouble with metal sheathing, explaining the need of demanding a guarantee that anti-fouling paint contains no metallic copper. 1600 w. Engs' Gaz—Aug., 1899. No. 29004 A.

Armament.

Rifled Naval Artillery. Andrew Noble. Abstract of a paper read at meeting of the Inst. of Naval Archts., England. Reviews progress since 1850 in the armament of battleships. 2700 w. Ind & Ir—July 21, 1899. No. 28876 A.

Battleship.

The New British Battleship "Vengeance." Description of a first-class battleship in process of construction. 2200 w. Engng—July 21, 1899. No. 28882 A.

Boilers.

On the Boiler Arrangement of Certain Recent Cruisers. F. T. Marshall. Comparison of systems used and description of arrangements adopted in recent vessels of the cruiser class. Ill. 5300 w. Engng—Aug. 11, 1899. No. 28889 A.

British Navy.

Ships Building for the British Navy. From *Black and White.* Illustration showing the great number of vessels in construction, with information relating to them. 1200 w. Sci Am Sup—Aug. 12, 1899. No. 28998.

Canal Boats.

Self-Propelling Steel Canal Boats. Waldon Fawcett. Describes these boats briefly, and gives information concerning a pontoon barge to be constructed for conveying these boats on the American Great Lakes from Cleveland to Buffalo and return. Ill. 1100 w. Sci Am—Aug. 26, 1899. No. 29178.

Cargo Handling.

Cargo Handling Machinery at Lake Erie Ports. Waldon Fawcett. Illustrates and describes the latest machinery for transferring coal and ore from vessel to car or from car to vessel. 4000 w. Am Mfr & Ir Wld—July 27, 1899. No. 28851.

Cargo Steamers.

Large Atlantic Cargo Steamers. G. B. Hunter. Read before the Institution of Naval Architects. Discusses some leading features of what the writer considers a typical American freight steamer of the present. Ill. 3000 w. Engng—Aug. 18, 1899. No. 29360 A.

Coal Consumption.

Coal Consumption in the British Navy. Editorial discussion of statements made and of Commodore Melville's arguments. 1800 w. Engr, Lond—Aug. 18, 1899. No. 29356 A.

Cruisers.

Faulty Features of Our Proposed Sheathed and Coppered Cruisers. Compares the proposed type with ships of a similar size and class among the navies of the world, with the conclusion that if built these vessels will be the least efficient of the seven compared. Also editorial. 2700 w. Sci Am—Aug. 19, 1899. No. 29088.

On Elswick Cruisers. Philip Watts. Read at meeting of the British Inst. of Naval Archts. Gives particulars of Elswick cruisers built during the last ten years. 3000 w. Engr, Lond—July 28, 1899. No. 28994 A.

Our First Large Cruisers. Detailed description, with illustration, of H. M. first-class cruisers "Blake" and "Blenheim." 3000 w. Engr, Lond—July 28, 1899. No. 28993 A.

Present and Proposed Cruisers of the United States Navy Compared. Gives illustrations of the new cruisers and the "New Orleans" comparing them and pointing out the advantage of one over the other. 1500 w. Sci Am—Sept. 2, 1899. No. 29388.

Docking.

Graphical Method of Finding the Pressure on Blocks Under a Ship Due to Overhang. H. S. Hele-Shaw. A letter with explanation of the graphic construction given. 1000 w. Engng—Aug. 4, 1899. No. 29071 A.

Dock Yards.

The Mechanical Appliances Employed in the Construction of the Keyham Dockyard Extension Works. Whately Eliot. Read before the Inst. of Mechanical Engs. Describes briefly, and illustrates, the machinery which is being employed in excavation, dealing with materials, building operations and work-shops. 3200 w. Engng—July 28, 1899. No. 28987 A.

Dry-Dock.

Floating Dry-Dock for the British Navy at Bermuda. Brief illustrated description of a dry dock capable of lifting a ship of 10,000 tons displacement. 400 w. Ry & Engng Rev—Aug. 5, 1899. No. 28963.

Naval Dry Dock at Boston. Illustrates and describes this large concrete structure, which is to cost $1,025,000. 2000 w. Marine Rev—Aug. 17, 1899. No. 29139.

The Supporting of Ships in Dry Docks. Francis Elgar. Read at Newcastle, before the Inst. of Naval Architects. Considers the distribution of pressure over the bottom of a ship in dry dock, and over the dock blocks, and to what extent it may become dangerously affected by conditions that sometimes arise in docking. Ill. 4500 w. Engng—July 28, 1899. No. 28986 A.

Ferryboat.

Propeller Feryboat Berkeley in Service in San Francisco Bay. Illustrated detailed description. 1100 w. Marine Engng—Aug., 1899. No. 28914 C.

Germany.

The Development of German Shipbuilding. Rudolph Haack. Herr Haack's second paper deals chiefly with the growth of the shipyards on the North Sea Coast, with many handsome illustrations. 3500 w. Engineering Magazine—Sept., 1899. No. 29292 B.

Gunboat.

The Boiler Trials of the "Sheldrake." An illustrated description of the new boilers and report of the trials, which gave very satisfactory results. 1200 w. Engr, Lond—Aug. 11, 1899. No. 29163 A.

Ice-Breakers.

Ice-Breakers. H. F. Swan. Read at meeting of the Inst. of Naval Archts. Gives particulars of two vessels of this class embodying the latest practice; the "Sampo," built for the Finnish Government, and the "Ermack," built for the Imperial Russian Government. 2300 w. Engr, Lond—July 21, 1899. No. 28887 A.

Launch.

On the Launch of a Battleship. H. R. Champness. A detailed description of the launching of a modern battleship and of the appliances used for the purpose. 6500 w. Engng—July 28, 1899. No. 28982 A.

Marine Engines.

Triple-Expansion Engines of H. M. SS. "Cheerful" and "Mermaid." Brief description and illustrations. 350 w. Engr, Lond—July 21, 1899. No. 28886 A.

Marine Growths.

Marine Growths—An Effective Argument for the Building of Dry Docks. H. Webster. Explains the causes which make necessary the docking and cleaning of ships, and the complications of the problem to be solved by the shipbuilder. 3000 w. Marine Engng—Aug., 1899. No. 28913 C.

Naval Engagement.

The Spanish-American War. On the encounter of the fleets at Santiago. Ill. 2000 w. Engng—July 21, 1899. No. 28878 A.

Naval Engineers.

The Engine-Room Staff. Editorial discussion of the position of engineers

in the British navy, and the grievances of the engine-room artificers. 1800 w. Engng—July 21, 1899. No. 28880 A.

Propulsion.

The Mechanical Theory of Steamship Propulsion. Robert Mansel. Briefly reviews published mathematical theories. 1800 w. Engr, Lond—Aug. 18, 1899. No. 29354 A.

Riveters.

Portable Pneumatic Riveters in Shipbuilding. W. J. Babcock. Read before the Inst. of Naval Archts., at the London meeting. Description and photographs showing the methods used. 2800 w. Engng—July 21, 1899. No. 28884 A.

School Ships.

Life of Naval Cadets and Apprentices on the German School Ships. Part first gives illustrations and particulars of the drill in sail manœuvres. 900 w. Sci Am Sup—Aug. 12, 1899. Serial. 1st part. No. 28997.

Ship Building.

Building a Ship. Philip Hichborn, in Boston *Sunday Herald*. A summary of progress from the earliest times, with details of modern practice in the construction of both wooden and steel vessels. 5200 w. Marine Rev—Aug. 17, 1899. No. 29138.

The Equipment of Shipbuilding Sheds. Illustrates and describes improvements at the works of Messrs. Swan & Hunter, Wallsend, Newcastle-on-Tyne. 900 w. Engr, Lond—Aug. 4, 1899. No. 29074 A.

Sounding.

A Bathometer Operating With Crushing Cylinders (Sur un Bathymetre Fondé sur l'Emploi de Cylindres Crushers). MM. Charbonnier and Galy-Arché. A device for determining depths of sea by the crushing pressure of the water upon cylinders such as are employed in determining artillery pressures. 1500 w. Comptes Rendus—July 24, 1899. No. 29226 D.

Speed.

The Speeds of Battleships. Editorial discussion of the value of speed, urging that if it is gained at the sacrifice of guns and armour the advantage is doubtful. 1500 w. Engr, Lond—Aug. 11, 1899. No. 29159 A.

Stability.

The Stability of Steamships and Sailing Vessels Under Light Burden (Sur la Stabilité des Vapeurs et des Navires à Voiles à l'Etat Lèger). A discussion of the effect of the absence of cargo upon stability, and also the effect of the distribution of the load. Serial. 1st part. 2000 w. Revue Technique—Aug. 10, 1899. No. 29218 D.

Steamships.

Machinery of H. M. SS. "Proserpine" and "Psyche" as Illustrative of the Work Done at Keyham, Particularly with Reference to the Practical Training of Engineer Students. Read at Inst. of Mech. Engrs., England. An illustrated detailed description. 3000 w. Engng—Aug. 18, 1899. No. 29362 A.

Thrust-Blocks.

Experiments on Thrust-Block Friction. F. von Kodolitsch. Read before the British Inst. of Naval Architects. Describes and illustrates the construction of the thrust-block and gives an account of experiments carried out to ascertain what percentage of the indicated horse-power is lost by friction. 1000 w. Engng—July 28, 1899. No. 28985 A.

Torpedo Boats.

What a Torpedo Boat is Like. Lawrence Irwell. Describes these boats and their development, the scanty quarters, and their action. 1500 w. Marine Rev—Aug. 3, 1899. No. 28967.

Tow Boats.

Large Steam Tenders. Illustrates and describes a fleet of five vessels under construction for the Mississippi River Commission by the Iowa Iron Works of Dubuque, Iowa. 1700 w. Marine Rev—Aug. 3, 1899. No. 28968.

Triple Screws.

Admiral Melville's Reply. Reply of the Engineer-in-Chief of the United States Navy to criticisms from English engineers regarding his advocacy of the use of triple screws in vessels of war. 3000 w. Am Mfr & Ir Wld—July 27, 1899. No. 28852.

Water Tubes.

Some Experiments Having Reference to the Durability of Water-Tube Boilers. A. F. Yarrow. Read at meeting of the Inst. of Naval Archts., England. Results of experiments recently carried out to ascertain the comparative merits of nickel steel tubes and tubes of mild steel. Ill. 2500 w. Engr, Lond—July 21, 1899. No. 28888 A.

The "Parole" Water-Tube Boiler. An illustrated description of this type, with report of test. 1400 w. Engng—July 21, 1899. No. 28879 A.

See Marine and Naval Engineering.

Wrecking.

Loss and Subsequent Recovery of the American Line Steamship "Paris." An account of the recent disaster, with en-

graving, and report of Capt. Frederick Watkins. 1500 w. Marine Engng—Aug., 1899. No. 28916 C.

Yachts.

"Columbia" and "Shamrock"—A Comparison. Estimates made show when the speed is over 8 knots an hour, "Shamrock" shows a slight advantage over a windward and leeward course, and "Columbia" a superiority over a triangular course. Also editorial. Ill. 3000 w. Sci Am—Aug. 12, 1899. No. 28995.

Strengthening the "Shamrock" for the Atlantic Voyage. Describes the provision made for the ocean voyage of this cup challenger. 500 w. Engr, Lond—July 28, 1899. No. 28992 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Efficiency Trials.

The Agricultural Hall Exhibition Efficiency Trials. Gives complete results of these trials. 1600 w. Automotor—Aug., 1899. No. 29336 A.

Electromobiles.

The Electromobile Exhibition of the Automobile Club de France. Constantin de Kubicki. A detailed description of the prominent types lately exhibited in Paris. Ill. 1800 w. Elec Rev, N. Y.—Aug. 23, 1899. No. 29171.

The Monnard Electromobile. Translation of an article by M. Delaselle in *La Locomotion Automobile*. Description, with several illustrations. 1200 w. Automotor—Aug., 1899. No. 29334 A.

Fire Engine.

A New Automobile Fire Engine. From *La Nature*. Illustrates and describes a fire engine invented by M. Porteu, which has been found to operate most successfully. 500 w. Sci Am Sup—Aug. 5, 1899. No. 28918.

French Regulations.

Automobile Regulations in France. A review of the new French regulations governing the use and sale of self-propelled vehicles of every type. 2100 w. Eng Rec—Aug. 12, 1899. No. 29036.

Liquid Air.

See Mechanical Engineering, Miscellany.

Liverpool Trials.

The Liverpool Heavy Motor Vehicle Trials. A full account of the trials, with illustrated description of the vehicles. Also editorial. 11300 w. Automotor—Aug., 1899. No. 29333 A.

The Liverpool Motor-Wagon Trials. Brief account of the second annual series of trials of motor-vehicles for heavy traffic. Describes vehicles and tests. 1500 w. Transport—Aug. 4, 1899. No. 29059 A.

Motor.

The Bolide Motor and Mechanism. Illustrated description. 700 w. Automotor—Aug., 1899. No. 29335 A.

Paris Exhibition.

Automobile Exhibition at Paris. Editorial on the second exhibition of automobiles held under the auspices of the Automobile Club of France, calling attention to tendencies in the evolution. 2200 w. Engng—July 21, 1899. No. 28881 A.

The International Competition of Heavy Weights (Concours International des Poids Lourds). The official report of the commission upon the exhibits and trials at the competiton of the Automobile Club of France in Oct., 1898; with many illustrations. Three articles, 1 plate. 25000 w. Génie Civil—July 29, Aug. 5, 12, 1899. No. 29203 each D.

Phaetons.

Phaetons at the Exposition of the Automobile Club. The first of a series of articles discussing the vehicles exhibited at the recent exposition in Paris. 1200 w. Sci Am Sup—Aug. 26, 1899. No. 29181.

Steam Wagon.

The Crouch Steam Wagon. Hugh Dolnar. Illustrated description. 1700 w. Am Mach—Aug. 17, 1899. No. 29109.

The Dudgeon Steam Wagon. Hugh Dolnar. Illustrated detailed description. 1500 w. Am Mach—Aug. 2, 1899. No. 29192.

Steering.

The Steering of Automobiles With Divided Axles (Du Virage des Automobiles à Essieux Brisés). D. Dujon. An analysis of the action of independently adjustable steering wheels, showing the method adopted for the prevention of slippage on short turns. 1200 w. Revue Technique—Aug. 10, 1899. No. 29219 D.

Trials.

The Paris Cab Trials. Translated from *Le Génie Civil*. An account of the June trials, with description of the vehicles. Ill. 6400 w. Automotor—Aug., 1899. No. 29337 A.

HYDRAULICS.

Hydraulic Pressure.

Use of Hydraulic Pressure in Engine Erection. Illustrates and describes its use at the 96th street power house, New York. 700 w. Power—Aug., 1899. No. 28898.

Pumping Engine.

Quadruple Expansion Pumping Engine at the Wildwood Station, Pittsburg, Pa. Three views, with side and front elevations, detailed description, and report of test. 3000 w. Power—Sept., 1899. No. 29387.

See Mining and Metallurgy, Mining.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

An Apprenticeship System in College Shops. O. P. Hood. Read at the Columbus meeting of the Society for the Promotion of Engineering Education. Explains the opinions that led to a trial of an apprentice system, the results, and the writer's belief in its usefulness. 1600 w. Am Mach—Aug. 24, 1899. No. 29195.

Boring.

Boring Cranks with Hydraulic Feed. H. S. Brown. Illustrates and describes a device arranged by the writer, with remarks on its uses, and on improved tools. 1700 w. Am Mach—Aug. 24, 1899. No. 29196.

Castings.

Producing Straight Castings, and Methods of Straightening. R. D. Moore. Considers various methods, and the treatment in special cases. 1700 w. Am Mach—Aug. 10, 1899. No. 29021.

Crane.

See Electrical Engineering, Power Applications.

Crank Position.

Finding the Position of the Crank when the Position of the Piston or Cross-Head is Given. Michele Ferrero. Gives a solution of this problem. 500 w. Am Mach—Aug. 17, 1899. No. 29108.

Cupola.

Improvements in Melting Furnaces (Neuerungen in Schmelzöfen). E. Herz. Illustrating and describing an improved foundry cupola, with auxiliary tuyeres and heated blast, by which a high economy is attained. 1500 w. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1899. No. 29252 D.

External Pressure.

Computation of External Pressure on Rings and Tubes (Berechnung des Zulässigen Aussendruckes bei Ringen und Röhren). Dr. P. Forchheimer. Deriving mathematical formulæ, and showing the reinforcing effect which may be expected from stiffening rings. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 1899. No. 29241 B.

Forge Shop.

A Model Heating and Ventilating System and Down Draft Forge Shop. An illustrated description of the apparatus used and plan of installation in the West Side High School Building of Milwaukee, and the down draft method of removing smoke in the forge shop of the same school. 1100 w. Heat & Ven—Aug., 1899. No. 29167.

Forging Machine.

The Rice Forging Machine at the Pope Mfg. Company. An illustrated detailed description of the machine and its operation. 3800 w. Ir Age—Aug. 24, 1899. No. 29184.

Gearing.

Epicyclic Gearing. Illustrates and explains its principles of operation and its application in machine design. 2800 w. Mach, N. Y.—Aug., 1899. Serial. 1st part. No. 28858.

Gears.

Elliptic Gears. Illustrates cases where elliptical gear wheels are employed to advantage. 900 w. Prac Engr—Aug. 18, 1899. No. 29348 A.

Iron Mixtures.

Silicon Control of Carbon in Cast Iron. F. E. Bachman. A contribution to the discussion of the paper of B. S. Summers, read at the Buffalo meeting of the Am. Inst. of Min. Engs. Paper, omitting the tables, giving the writer's comments, which differ from the usual teaching concerning silicon. 1500 w. Ir Trd Rev—Aug. 3, 1899. No. 28928.

Labor-Saving.

Some Devices at the Meadows Shops of the Pennsylvania Railroad. Illustrates and describes some useful labor-saving devices in daily use at these shops. 900 w. R R Gaz—Aug. 25, 1899. No. 29198.

Machine Driving.

See Electrical Engineering, Power Applications.

Malleable Iron.

Malleable Cast Iron—Its History in the United States. George C. Davis. Reviews the practice in earlier times, the difficulties encountered, some of the earlier foundries, etc. Ill. 3800 w. Jour Fr Inst—Aug., 1899. Serial. 1st part. No. 28945 D.

The Basic Furnace for Malleable Iron. E. C. Wheeler. A discussion of facts relating to the malleable industry, and the possibilities of the basic furnace. 3800 w. Foundry—Aug., 1899. No. 29168.

Mechanical Works.

The Mechanical Works and Operations of Manchester and District. Gives illustrated description of the important works and their products. 10500 w. Ir & Coal Trds Rev—Aug. 11, 1899. No. 29352 A.

Melting.

Melting Iron for Foundry Purposes. Walter J. May. Some points on cupola and crucible furnaces and their management. 1100 w. Prac Engr—July 28, 1899. No. 28977 A.

Metal Work.

Metal Work. T. Swaffield Brown. Abstract of a paper read before the Sheffield Society of Architects. On the principles and processes, the materials used, etc. Ill. 4000 w. Can Archt—Aug., 1899. No. 29129 C.

Milan, Italy.

The Shops and Products of Brioschi Finzi & Co., Milan, Italy. Illustrated description of five shops, the chief products being electric generators and motors. 900 w. Am Mach—Aug. 17, 1899. No. 29107.

Molding.

Molding a Double Cylinder. Joseph Horner. Illustrated detailed description. 2000 w. Mech Wld—Aug. 4, 1899. Serial. 1st part. No. 29061 A.

Pump Governor.

Control of Pumps by Means of Dynamometric Indicator (Contrôle des Pompes au Moyen de l'Indicateur Dynamométrique). Emile Colmant. With numerous indicator diagrams showing how the fluctuations of pressure in the water cylinder may be used to govern the action. 4500 w. Rev Univ des Mines—July, 1899. No. 29228 G.

Repairs.

Boiler Patching. W. G. Ranton. Describes the two methods known as soft and hard patching. 1600 w. Power—Aug., 1899. No. 28899.

Riveters.

See Marine and Naval Engineering.

Shop Hints.

Some Shop Hints. Illustrates and describes some interesting tools and methods used in the shops of the Calumet Electric Street Ry. Co., Chicago. 1400 w. St Ry Rev—Aug. 15, 1899. No. 29112 C.

Small Tools.

Cutter Bars and Chucking Reamers. H. S. Brown. Illustrates and describes these tools which have been recently much improved. 1100 w. Am Mach—Aug. 17, 1899. No. 29110.

Stamping.

A Difficult Job of Stamping. E. E. Minard. Illustrates and describes the tools used and the method of making the stamping shown. 900 w. Am Mach—Aug. 10, 1899. No. 29023.

Strengthening Pipes.

Method of Strengthening Copper Steam Pipes Longitudinally. T. Messenger. Read before the Northeast Coast Inst. of Engs. & Shipbuilders, England. Illustrates and describes the system adopted by the writer. 500 w. Marine Engng—Aug., 1899. No. 28915 C.

Tools.

Machine Tools—Their Construction and Manipulation. W. H. Van Dervoort. Aims to bring out clearly the principal points of construction and methods of operation. Ill. 2500 w. Mach, N. Y.—Aug., 1899. Serial. 1st part. No. 28859.

Verification.

The Optical Verification of Lines and Surfaces (Vérificateurs Optiques des Lignes et Surfaces). Ch. Dévé. An elaborate discussion of the optical methods which may be employed in mechanical operations for verifying the accuracy of planes. A long and valuable paper. 1500 w. Bull de la Soc d'Encour—July, 1899. No. 29221 G.

Wages.

A Logical System of Wages. John Richards. Discusses the present methods of compensating labor, and suggests a co-operative contract system, illustrating by example. 3500 w. Am Mach—Aug. 24, 1899. No. 29194.

Systems for the Remuneration of Labor. P. J. Darlington. A critical examination of the claims of the Premium system, in comparison with the Piece Rate method, showing the deficiencies of the former system. 4500 w. Engineering Magazine—Sept., 1899. No. 29293 B.

Work Shop.

A "Fin-de-Siecle" Machine Shop. Fred. Bathurst. Describes and illustrates machines in a fine shop in Austria. 3000 w. Elec Rev, Lond—Aug. 18, 1899. Serial. 1st part. No. 29343 A.

MATERIALS OF CONSTRUCTION.

Association.

The Work of the International Association for Testing Materials. An ad-

dress by Prof. Mansfield Merriman, chairman of the American section of the Assn., at the Pittsburg meeting. A review of the progress in ascertaining the properties of materials of construction, and establishing rules for testing. 3000 w. Eng News—Aug. 17, 1899. No. 29099.

Bicycle Tubes.

Strength of Bicycle Tubes. Oberlin Smith. Reviews briefly seamless tube drawing and describes tests made, giving results of some 28 tests of pieces about 15 inches long. Ill. 1900 w. Jour Gas Lgt—Aug. 3, 1899. No. 28911 A.

Cast-Iron Tests.

Influence of the Length of Span in Transverse Tests of Cast-Iron. Dr. R. Moldenke. Describes a series of tests made and gives the averages of the results obtained. 1400 w. Eng News—Aug. 17, 1899. No. 29102.

The American Foundrymen's Association Tests on Cast Iron as Related to Electrical Machinery. R. Moldenke. Gives a brief outline of the plans and study of the work already completed in which designers and builders of electrical machinery will be interested. 2500 w. Elec Wld—Aug. 26, 1899. No. 29314.

Elasticity.

Experiments Upon the Difference in Elasticity of Chilled Iron and Ordinary Cast Iron (Untersuchungen über den Unterschied der Elastizität von Hartguss und von Gusseisen Gewöhnlicher Härte). C. Bach. Discussing particularly the behavior of irons of different hardnesses when used as the runway for ball-bearings under heavy pressure. 7500 w. Zeitschr d Ver Deutscher Ing—July 22, 1899. No. 29245 D.

Enameling.

Enameling as an Industry. Josef Vollkomuser, in *The Metal Worker*. Considers the materials used, their composition, the preparation of the metal, cost, etc. 2300 w. Dom Engng—Aug., 1899. No. 29133 C.

Expansion.

The Expansion of Iron and Steel at High Temperatures (Sur la Dilatation du Fer et des Aciers aux Températures Elevées). H. Le Chatelier. A communication to the French Academy showing the relation between the expansion and the molecular transformation of iron and steel. 1200 w. Comptes Rendus—Aug. 7, 1899. No. 29232 D.

Fractures.

Pig-iron Fractures and Their Value in Foundry Practice. J. W. Miller. On the unreliability of grading based on fracture and the value of chemical analysis. 3300 w. Ir & Coal Trds Rev—Aug. 18, 1899. No. 29369 A.

Impact Tests.

Impact Tests of Structural Steel. S. Bent Russell. Illustrates and describes tests made by a new method under which the specimens were broken by tensile stress, giving results. 4500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29302 E.

Metallography.

The Mechanical Uses of the Science of Metallography. Albert Sauveur. A fully illustrated exposition of the method of studying the physical structure of metals by magnified etched sections showing the great practical value of the system in daily use. 4500 w. Engineering Magazine—Sept., 1899. No. 29297 B.

Mineral Wool.

The Manufacture of Sulphur-Free Mineral Wool. A. D. Elbers. Gives the history of the manufacture of this product, and the invention which makes it quite certain such an article can be produced. 2000 w. Eng & Min Jour—Aug. 26, 1899. No. 29329.

Nickel Steel.

Temporary and Residual Variations in Reversible Nickel-Steel Alloys (Sur les Variations Temporaires et Résiduelles des Aciers au Nickel Réversibles). C. E. Guillaume. A continuation of the experiments of the author upon nickel-steel alloys, with especial reference to the construction of standards 1500 w. Comptes Rendus—July 17, 1899. No. 29223 D.

Oil Testing.

Notes from the Oil Testing Department (Aus der Abtheilung für Oelprüfung). A number of brief notes by Dr. Holde, in charge of the department of testing lubricants at the Royal testing laboratory at Charlottenburg. Questions of viscosity, gravity and inflammability are discussed. 4000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part II., 1898. No. 29238G.

Steel Pipe.

Friction Coefficient for Riveted Steel Pipe. A. McL. Hawks. Informal discussion of what is the proper friction coefficient for use in the design of riveted steel pipe. 1600 w Pro Am Soc of Civ Engs—Aug., 1899. No. 29305 E.

Transformations.

The Changes of State of Iron and Steel (Sur les Changements d'Etat du Fer et de l'Acier). H. Le Chatelier. A communication to the French Academy giving the results of investigations into

the phenomena of recalescence, and of magnetic and physical transformations. 1500 w. Comptes Rendus—July 31, 1899. No. 29231 D.

POWER AND TRANSMISSION.

Animal Energy.

The Development of Energy by a Man Raising and Lowering His Own Weight (Thermogénère et Depense Energétique chez l'Homme qui Elève ou Abaisse son Propre Poids). A. Chauveau. A very full account of the author's experiments upon animal energy, with measurements of the heat developed, and the work performed. 3500 w. Comptes Rendus—July 31, 1899. No. 29229 D.

Air Friction.

The Variable Coefficient in Formulas for Friction of Air—Determination of the Coefficient. J. E. Johnson, Jr. Discusses a possible origin of the variable coefficient. Supplementary to an article published July 27, which considered the constant coefficient only. 1700 w. Am Mach—Aug. 3, 1899. No. 29169.

Pneumatic Transmission.

The Transmission of Energy by a Partially Rarified Atmosphere. Frederick Bramwell, Sir Frederick Bramwell. Read at the Plymouth meeting of the Inst. of Mech. Engrs. Reviews the history of the development of this mode of transmission, and its application to railways, especially considering the South Devon Atmospheric Railway. 5500 w. Engr, Lond—Aug. 18. 1899. No. 29-357 A.

Regulation.

The Regulation of Power Machinery (Das Regulíren von Kraftsmaschinen). J. Isaachsen. A general discussion of the fundamental principles of the regulation of motors, including steam and hydraulic machinery, in connection with a consideration of the inertia of the moving masses. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 5, 1899. No. 29-247 D.

SPECIAL MOTORS.

Diesel Motor.

Diesel Motor in America. A brief account of Rudolph Diesel and his work, with illustrated description of the engine. 1200 w. Mod Mach—Aug., 1899. No. 28955.

Improvements in the Diesel Motor. States the principles of the method for effecting ignition and combustion in internal combustion motors. Ill. 1000 w. Automotor—Aug., 1899. No. 29338 A.

Furnace Gas.

See Gas Engineering.

Gas Engines.

A Few Uses for Cylinder Cooling-Water of Gas Engines. O. F. Allen, in *The Gas Engine*. Mentions a few means for saving the heat of cylinder-cooling water. 1500 w. Mech Wld—Aug. 4, 1899. No. 29062 A.

A 650-Horse Power Gas Engine. Illustrates and describes a large three-cylinder gas engine of the Westinghouse type. 800 w. Col Guard—Aug. 4, 1899 No. 29076 A.

Petroleum Motor.

Petroleum Motors, with Especial Reference to the New Motors of Diesel and of Dopp (Ueber Petroleum-Motoren mit besonderer Berücksichtigung der Neueren Motoren von Diesel und von Dopp). A paper before the German Society of Mechanical Engineers showing that the Dopp Motor gives results as economical as the Diesel. 6000 w. Glaser's Annalen—July 15, 1899. No. 29248 D.

The New Mors Vertical Petroleum-Spirit Motor. Illustrates and describes a new motor of the vertical twin-cylinder type, capable of working up to 8 h. p. 900 w. Ind & Ir—Aug. 4, 1899. No. 29069 A.

STEAM ENGINEERING.

Accidents.

Accidents to Steam Boilers (Accidents d'Appareils à Vapeur). The official report for France for 1897, with numerous illustrations and data concerning boiler explosions and other disasters to steam apparatus. 7000 w. 4 plates. Aun des Ponts et Chaussées—1 Trimestre, 1899. No. 29215 E + F.

Blow-Offs.

Blow-Off Pipes. H. H. Kelley. Discusses the care necessary and often neglected, and the proper location of the blow-off pipe and construction of boiler settings. Ill. 2500 w. Engr, U. S. A.—Aug. 1, 1899. No. 28929.

Boiler Efficiency.

Mechanical Draft and Boiler Efficiency. Extracts from a paper by Walter B. Snow showing a saving in first cost and in operating expenses, and increased efficiency of the plant. 1400 w. Ir Trd Rev—Aug. 10, 1899. No. 29015.

Boilers.

Boilers With Steam Circulating Device (Chaudières avec Emulseur à Vapeur). An illustrated description of the boilers at the Cambria sugar refinery; being boilers of the elephant type with circulating pipes connecting the steam space to the heaters. 2000 w. 1 plate. Génie Civil—Aug. 5, 1899 No. 29205 D.

The Low Water Scapegoat. Editorial on the injustice of always attributing boiler explosions to low water. 700 w. Loc Engng—Sept., 1899. No. 29372 C.

See Marine and Naval Engineering.

Boiler Tubes.

See Railway Affairs, Motive Power.

Cleaning Boilers.

Method for Cleaning Boiler Tubes. Illustrates and explains the new method being introduced by the Union Boiler Tube Cleaner Co., of Pittsburg. 1200 w. Am Mfr & Ir Wld—Aug. 17, 1899. No. 29136.

Chimney.

A Ventilated Chimney Tower. Illustrated description of an aspirating chimney in a New York Hospital. 700 w. Eng Rec—Aug. 19, 1899. No. 29128.

Design and Computations for Steam Boiler Chimneys (Einheitliche Bestimmung über Anordnung und Abmessung von Schornsteinen für Dampfkesselanlagen). G. Lang. A very exhaustive treatment of the subject of masonry chimney design, discussing the subjects of proportions and constructive details for various conditions. Two articles. 10,000 w. Zeitschr d Ver Deutscher Ing—July 29, Aug. 5, 1899. No. 29246 each D.

Tests of Masonry for Chimney Construction (Prüfung von Schornsteinmauerwerk). M. Gary. A report of tests made at the government testing laboratory at Charlottenburg, with many illustrations, diagrams and tables. 6000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part II., 1899. No. 29237 G.

Coal Consumption.

See Marine and Naval Engineering.

Coal Tests.

Comparative Tests of Bituminous Steam Coals. William H. Bryan and R. C. Carpenter. Discussion of paper by John W. Hill. 2500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29308 E.

Combustion.

Mechanical Draft. Henry B. Prather. Gives a review of the most important systems, and emphasizes the importance of giving proper attention to the firing of the boilers. 4500 w. Jour Assn of Engng Socs—July, 1899. No. 29379 C.

Exhaust Steam.

The Project to Warm Buildings from a Central Station in Providence, R. I. Abstract of a report by J. E. Denton on the relative economy of heating buildings by individual plants and by exhaust steam from a large power station. 3800 w. Eng Rec—Aug. 19, 1899. No. 29127.

Forced Draught.

A New Method of Forced Draught. Nelson Foley. Read before the Inst. of Naval Archts., at the Newcastle-on-Tyne meeting. Describes a system where the fire bars themselves are used as a means of forcing the air into the fire. Ill. 800 w. Engng—July 21, 1899. No. 28883 A.

Heat Losses.

Heat Losses in a Steam Boiler. W. F. Durand, in *The Boiler Maker*. Discusses the losses in the furnace, due to incomplete combustion, and the loss in the boiler. 3000 w. Ir Trd Rev—July 27, 1899. No. 28853.

Piping.

The Arrangement of Steam and Other Pipes, and Their Fittings. J. E. Edgcome. Read before the Munic. Elec Assn. Also discussion. Views concerning the arrangement especially in central stations of small or moderate size. Ill. 5000 w. Elect'n, Lond—July 21, 1899. No. 28871 A.

Pulverized Fuel.

Firing With Pulverized Coal (Kohlenstaubfeuerungen). A general review of the use of powdered coal, especially for boiler firing, both in connection with economy and smoke prevention. Various furnaces are described. Four articles. 4000 w. Schweizerische Bauzeitung—July 8, 15, 22, 29, 1899. No. 29263 each B.

Smoke.

Smoke Consumption and Economy of Fuel. Frank H. Mason. Describes the process of Mr. Paul Cornelius for the consumption of low-grade fuels, as exhibited in Berlin, Germany. 1800 w. Am Arch—July 29, 1899. No. 28855.

Smokeless and Smoke-Consuming Furnaces (Rauchlose und Rauch Verbrennende Feuerungen). W. Häntzschel. A discussion of the smoke problem with especial reference to the advantages of pulverized fuel; giving a description of the Wegener furnace. 3000 w. Gesundheits-Ingenieur—Aug. 15, 1899. No. 29256 B.

The Smoke Nuisance. Editorial on the attitude of the English people toward this question, the loss it represents, the need of educating public opinion, etc. 3000 w. Builder—Aug. 12, 1899. No. 29150 A.

Smokeless Firing.

See Railway Affairs, Motive Power.

Steam Engines.

A Forgotten Steam Engine. Editorial on an engine patented by Watt in 1769 which is claimed to be the most perfect

steam engine, from the thermal efficiency point of view, it is possible to construct. 1800 w. Engr, Lond—Aug. 11, 1899. No. 29160 A.

High-Speed Engines. Illustrated abstract of paper by J. H. Dales before Inst. Civ. Engs. on new methods of adjusting clearance in bearings and governing double-acting engines for high speeds. 4000 w. Eng Rec—Aug. 12, 1899. No. 29037.

Rolling Mill Engines (Walzenzugmaschinen). Giving illustrated description of a cross-compound reversing engine, and of a Schmidt tandem compound engine for superheated steam, with diagrams showing the distribution of pressures on the crank pin. 1000 w. 1 plate. Stahl und Eisen—July 15, 1899. No. 29257 D.

Rolling-Mill Reversing Engines. Illustrated detailed description of engines built for the Keystone Axle Company, of Beaver Falls, Pa., giving dimensions. 500 w. Engng—Aug. 11, 1899. No. 29165 A.

See Marine and Naval Engineering.

Steam Turbine.

Parsons' Steam Turbine. An account of the work done by Mr. Parsons, in introducing the steam turbine, with some of the results. Ill. 3400 w. Engng—Aug. 18, 1899. Serial. 1st part. No. 29358 A.

Superheating.

Economy in the Use of Superheated Steam. R. S. Hale. A conservative examination of the economy to be anticipated from the use of superheated steam, showing the conditions under which it should be practically successful. 2500 w. Engineering Magazine—Sept., 1899. No. 29291 B.

Superheated Steam—Its Use and Advantages. Ernst Prochaska. Remarks on the results obtained by the use of highly superheated steam, with description of Hering's steam superheater, and report of trials. Ill. 1300 w. Am Mfr & Ir Wld—Aug. 3, 1899. No. 28927.

Thermal Efficiency.

Report on the Thermal Efficiency of Steam Engines. A discussion of the report presented by the committee appointed by the Institution of Civil Engs. 4000 w. Engr, Lond—Aug. 18, 1899. No. 29353 A.

Valves.

An Improved Allen Valve. Illustrations and description of improved Allen valve brought out by the Richmond Locomotive Works with indicator diagrams showing effect of the change. 700 w. Loc Engng—Sept., 1899. No. 29375 C.

Safety Valves. H. H. Kelley. The Danger of neglecting safety valves, and the principle involved in the safety-valve lever. 3000 w. Engr, U. S. A.—Aug. 15, 1899. No. 29113.

Safety Valves. Illustrates and describes various types. 2800 w. Am Elect'n—Aug., 1899. No. 28862.

The Andrews and Martin Balanced Slide Valves. Illustrates and describes a valve more especially intended for use on marine engines, stating its advantages. 1600 w. Engng—Aug. 11, 1899. No. 29166 A.

The Richmond Double-Ported Valves. Features of the valve and diagrams showing comparative results of its use, with description and arguments for its use as given by Mr. Mellin. 600 w. R R Gaz—Aug. 18, 1899. No. 29115.

Water Hammer.

Water Hammer in Steam Pipes (Chocs de l'Eau dans les Conduites de Vapeur). M. Walckenaer. A discussion of the causes of water hammer in steam pipes, with illustrations of ruptures due to this cause and suggestions as to their prevention. 5000 w. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29-214 E + F.

Water Tubes.

Water Tube Boilers. Robert S. Ball. A statement of the advantages of this type for large mining plants. 1100 w. Col Guard—Aug. 11, 1899. No. 29152 A.

MISCELLANY.

Air Resistance.

Researches Upon the Resistance of the Air (Recherches sur la Resistance de l'Air). The papers of M. Le Dantec and M. Canovetti, giving data and results of their experiments. A valuable contribution to knowledge. 10,000 w. Bull de la Soc d'Encour—July, 1899. No. 29220 G.

Bicycles.

Cycle Construction and Design. Archibald Sharp. This first lecture deals with the construction and design of the frame of the present-day type. Ill. 4000 w. Jour Soc of Arts—Aug. 18, 1899. Serial. 1st part. No. 29331 A.

Compressors.

The Air Compressor. O. G. Smith. A statement of the features of the process of air compressing. 1300 w. Min Rept —Aug. 17, 1899. No. 29173.

Education.

Technical High Schools and Scientific Investigation (Die Technischen Hochschulen und die Wissenschaftliche Forschung). An address by Prof. Riedler at the Technical High School

at Charlottenburg comparing the work of that institution with the German universities. 4000 w. Zeitschr d Ver Deutscher Ing—July 15, 1899. No. 29-244 D.

Gun Pressure.

The Law of Pressures in Gun Barrels (Sur la Loi des Pressions dans les Bouches à Feu). E. Vallier. Giving formulas and tables for various weights of charges, projectiles and initial velocities. 1200 w. Comptes Rendus—July 31, 1899. No. 29230 D.

Liquid Air.

Liquid Air as Portable Power. Frank Richards. Suggesting how liquid air could be used in this manner. 1200 w. Am Mach—Aug. 3, 1899. No. 28912.

Liquid Air for Automobile or Portable Service. Frank Richards. Outlines a scheme for using liquid air for an autocar motor. 1200 w. Am Mach—Aug. 10, 1899. No. 29022.

Refrigeration.

Ice Manufacture on a New System. Illustrates and describes the Holden system of ice manufacture, which can produce ice at a cost of 50 cts a ton. 2200 w. Sci Am—Sept. 2, 1899. No. 29389.

Science and Engineering.

The Relation of Physics and Astronomy to the Development of the Mechanic Arts. Cleveland Abbe. An address to the Franklin Institute on the inauguration of a new branch entitled "The Section on Astronomy and Physics," showing the close relation of the sciences to the mechanic arts. 14000 w. Jour Fr Inst—Aug., 1899. No. 28-944 D.

The Scientist and the Engineer. Editorial comment and several recent addresses showing the importance of a mutual understanding. 1500 w. Eng Rec—Aug. 12, 1899. No. 29032.

Thermophone.

An Instrument for Indicating Temperatures at a Distance. Illustrated detailed description of the instrument and its operation. 1500 w. Eng News—Aug. 17, 1899. No. 29106.

MINING AND METALLURGY

COAL AND COKE.

Bosnia.

Coal Mining in Bosnia (Mittheilungen über den Kohlenbergbau in Bosnien). F. Poech. A general review of mining conditions in Bosnia, with illustrations of the arrangements of machinery, and profiles and sections of the workings. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 29, 1899. No. 29283 B.

Coal Mining in Bosnia. F. Poech. From *Oesterrichische Zeitschrift für Berg-und-Huttenwesen.* Describes the quality of the coal, method of working, the deposits, and gives information of general interest. Ill. 2000 w. Col Guard—Aug. 4, 1899. No. 29078 A.

Coal Fields.

The Coal Fields of the Southern States of America. Reports the exceptional development in this area, extending from the Virginias through southeastern Kentucky and Tennessee into north-west Georgia and Alabama. 1800 w. Col Guard—July 28, 1899. No. 28989 A.

Coal Tests.

See Mechanical Engineering, Steam Engineering.

Coke-Oven Gas.

The Everett Coke-Oven Gas Plant. Dr. F. Schniewind. Describes and illustrates the works, their location, transportation facilities, coal-handling plant, coke ovens, etc. 4400 w. Pro Age—Aug. 15, 1899. Serial. 1st part. No. 29083.

New Zealand.

Coal Mining in New Zealand. Harrison F. Bulman. Information concerning the deposits, working, and coal mines act. 2400 w. Col Guard—July 21, 1899. No. 28890 A.

Coal Mining in New Zealand. Harrison F. Bulman. Information concerning the deposits, quality of the coal and manner of working. Ill. 1500 w. Col Guard—Aug. 18, 1899. No. 29363 A.

Shipping.

Coal Shipping. George Johnson. Information relating to business methods, charges, etc., in England. 2800 w. Col Guard—July 21, 1899. No. 28891 A.

South Wales.

The Re-Survey of the South Wales Coalfield. From the Summary of Progress of the Geological Survey of the United Kingdom for 1898. 2800 w. Col Guard—Aug. 18, 1899. Serial. 1st part. No. 29367 A.

COPPER.

Metallurgy.

The Metallurgy of Copper. H. Van F. Furman. Describes its chemical and physical properties and the various methods of extracting the metal from the ore. 3300 w. Mines & Min—Aug., 1899. No. 28953 C.

Production.

The World's Copper Production in 1898. Table showing the production from 1894-1898 with comment on the growth, and the important position of the United States as a producer. 1000 w. Eng & Min Jour—Aug. 12, 1899. No. 29028.

GOLD AND SILVER.

Africa.

The Gold Mines of the Gold Coast, Africa. Abstract from London *Financial News*. Supplement. Brief review of the past history and future prospects of this promising field. 1500 w. Eng & Min Jour—Aug. 5, 1899. No. 28966.

Australia.

A Neglected Gold Field. Reginald H. L. Hobby. Information concerning the Dark River field, about 240 miles from Melbourne. 1100 w. Aust Min Stand—June 20, 1899. No. 28908 B.

The Berringa Gold Field (V.). William Bradford. An account of the auriferous features and mining efforts. Part first considers the birthday group. Ill. 3000 w. Aust Min Stand—July 6, 1899. Serial. 1st part. No. 29097 B.

Cyanide Mill.

A Description of the Arequa Cyanide Mill at Cripple Creek, Colorado. Arthur Lakes. Describes how the ore is treated, and the machinery used in sampling, roasting and leaching it. Ill. 3000 w. Mines & Min—Aug., 1899. No. 28948 C.

Idaho.

The Buffalo Hump Mining Camp, Idaho. Charles L. Whittle. Describes the region, the camp, the quartz vein found, and a few claims near. 2000 w. Eng & Min Jour—Aug. 19, 1899. No. 29131.

Ores.

Notes on Milling of Low Grade Gold Ores. Edward W. Dee. Results of the experience and observation of a Colorado mine manager. 4800 w. Mod Mach —Aug., 1899. Serial. 1st part. No. 28-956.

Panama Deposits.

Age and Origin of Certain Gold Deposits on the Isthmus of Panama. Oscar H. Hershey. Of interest because the veins are of recent origin as compared with most gold-bearing ledges. 2000 w. Am Geol—Aug., 1895. No. 28946 D.

Patio Process.

The Patio Process in Guanajuato, Mexico. Roberto Fernandez. An explanation of this process for the treatment of silver ores, and the class of ores to which it is best adapted. 1700 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29053 D.

Placer Deposits.

Testing and Sampling Placer Deposits. Edmund B. Kirby. Abstract of a paper read before the Colorado Scientific Society. Outlines the evidence to be secured by tests, etc., and the methods used in test workings. 2000 w. Eng & Min Jour—July 29, 1899. No. 28857.

Precipitation.

Note on Gold Precipitation by Zinc Dust. George A. Packard. Describes the method as used at the Mercur mines in Utah. 800 w. Jour Chem & Met Soc of S Africa—June, 1899. No. 28973 E.

Production.

The World's Silver Production. Shows the production of 1898 to have been larger than any year since 1892 and gives information of interest. 900 w. Eng & Min Jour—Aug. 19, 1899. No. 29130.

Slimes.

Notes on Sampling, Analyzing, and Treating Slimes. L. Ehrmann. Gives plan and description of an automatic sampler devised by the author, and discusses precipitation of slimes by milk of lime. 3300 w. Jour Chem & Met Soc of S Africa—June, 1899. No. 28972 E.

Veins.

Extensions of Great Veins. Arthur Lakes. How to follow them and some points to be considered in locating a claim on them. Ill. 2500 w. Mines & Min—Aug., 1899. No. 28952 C.

Wyoming.

The Grand Encampment and Saratoga Mining Districts of Wyoming. Thomas Tonge. An account of the region, its prospects and development. 2000 w. Mines & Min—Aug., 1899. No. 28954 C.

Zambesia.

Ancient Ruins and Gold Mines in Zambesia. From an account sent by Dr. Karl Peters to the London *Times*. The article describes the very ancient remains found, and mentions the mountain of Fura, very rich in gold. 1400 w. Eng & Min Jour—Aug. 12, 1899. No. 29029.

IRON AND STEEL.

Algiers.

The Iron Mines of Rar-el-Maden (Die Eisenerzgrube von Rar-el-Maden). With illustrations of these extensive mines, near Oran, Algiers, showing the cableways, and methods of working. 1000 w. Stahl und Eisen—July 15, 1899. No. 29259 D.

Annealing.

Brittleness Produced in Soft Steel by Annealing. John Edward Stead. Read before the Iron and Steel Inst., at the Stockholm meeting. A study of this subject giving the results of careful investigation. Ill. 5800 w. Bridges—July, 1899. No. 28961 C.

Austria.

The Development of the Austrian Iron Industry During the Past 50 Years (Entwicklung der Oesterreichischen Eisenindustrie in den Letzten 50 Jahren). A review presented at the semi-centennial celebration of the Austrian Society of Engineers and Architects. 3000 w. Stahl und Eisen—July 15, 1899. No. 29260 D.

Barrow Steel Co.

The Works and Operations of the Barrow Hemetite Steel Company. Illustrated detailed description of the works, with brief historical account. 5500 w. Ir & Coal Trds Rev—Aug. 4, 1899. No. 29067 A.

Cast-Iron.

The Silicon-Control of Carbon in Cast-Iron. F. E. Bachman. A discussion of the paper of Mr. Summers on "Modern Cupola Practice, etc." Gives tabulated analyses of the pig-iron of the Buffalo furnace, made during three years, from ore-mixtures varying slightly; also analyses of other irons from different places. 5000 w. Trans Am Inst of Min Engrs—Oct., 1898. No. 29052 D.

Carbon Combustions.

Carbon Combustions in a Platinum Crucible. P. W. Shiner. Illustrates and describes an apparatus devised by the writer, using a platinum crucible, with a water-cooled stopper, in place of the porcelain or platinum tube; an ordinary blast-lamp and Bunsen burner in place of the combustion furnace; and air instead of oxygen. 1800 w. Am Mfr & Ir Wld —Aug. 17, 1899. Serial. 1st part. No. 29137.

Cuba.

The Iron Mines of Cuba. A report by Robert P. Porter. Shows past and present conditions and the effect of the recent military operations on this industry. 2200 w. Ir Age—Aug. 17, 1899. No. 29095.

Cupola.

See Mechanical Engineering, Foundries.

Furnace Gas.

See Gas Engineering.

India.

I. The Iron Industry in the Territory of His Highness the Nizam Shamsul Ulama Syed Ali Bilgrami. II. India as a Center for Steel Manufacture. R. H. Mahon. Two papers read before the British Iron and Steel Inst., and discussed together. The first deals with the kinds of ores found; and the second records facts relating to the possibility of manufacturing iron and steel at a profit in India. 4000 w. Col Guard—Aug. 18, 1899. No. 29365 A.

Iron Mixtures.

See Mechanical Engineering, Foundries.

Iron Ores.

Iron Ores of the Potsdam Formation in the Valley of Virginia. Charles Catlett. A description of the general nature of these ores, cost of mining, capacity of the deposits, methods, etc. 4000 w. Trans Am Inst of Min Engrs—Feb., 1899. No. 29054 D.

Use of Finely-Divided Iron Ore. J. Wiborgh. Read before the British Iron and Steel Inst. Considers the ways in which powdered iron ores obtained by concentration may be utilized. Ill. 3500 w. Col Guard—Aug. 18, 1899. No. 29364 A.

Italy.

A Study of the Iron District of Lombardy (Studie über die Eisenindustrie in der Lombardie). A very full review of the iron production in Northern Italy, with map, and details of operation and cost; the district produces about 30,000 tons per year. Two articles. 1 plate. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 5, 12, 1899. No. 29284 each B.

Magnetic Ores.

Investigation of Magnetic Iron Ores from Eastern Ontario. Frederick J. Pope. Considers some of the relations existing between the geological associations and elementary constituents of their iron-ore bodies. 11800 w. Trans Am Inst of Min Engrs—Oct., 1899. No. 29055 D.

Malleable Iron.

See Mechanical Engineering, Foundries.

Melting.

See Mechanical Engineering, Foundries.

Meteoric Iron.

Note on a New Meteoric Iron Found Near the Tombigbee River, in Choctaw and Sumter Counties, Alabama, U. S. A. Warren M. Foote. An outline of the history of these masses, so far as known. Plates. 1300 w. Am Jour of Sci—Aug., 1899. No. 28894 D.

Separators.

Some Forms of Magnetic Separators, and Their Application to Different Ores. H. C. McNeill. Read before the British Iron and Steel Inst. Illustrates and describes some of the principal magnetic concentration plants of Sweden. 6000 w. Col Guard—Aug. 18, 1899. No. 29368 A.

Steel.

The Relation Between the Structure of Steel and Its Thermal and Mechanical Treatment. Albert Sauveur. Read before the Iron and Steel Inst. of Great Britain. Considers the changes of structure brought about by heat treatment, the changes by work, and gives conclusions of interest. 4300 w. Eng News—Aug. 24, 1899. No. 29190.

MINING.

Accidents.

Accidents from Falls of Roof and Side. Statement issued by Sir Kenelm E. Digby, giving precautions recommended for general adoption. 1000 w. Col Guard—Aug. 11, 1899. No. 29155 A.

Coal-Cutting.

Coal-Cutting Machinery. Edward W. Parker. Discusses only those machines which have survived the test of practice, and have shown by actual use the success of applying mechanical methods to the mining of bituminous coal. 13500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29056 D.

Drill Holes.

Drift in Diamond-Drill Holes. H. M. Lane. On the amount of dependence that can be placed upon the apparent position of the end of the diamond-drill holes. 1900 w. Mines & Min—Aug., 1899. No. 28949 C.

Explosives.

The Government and Permitted Explosives in Coal Mines. Concerning the new order which repeals the two orders now in force in the United Kingdom, and embodies their contents with additions and alterations. This order takes effect Oct. 1, 1899. 1400 w. Ir & Coal Trds Rev—Aug. 4, 1899. No. 29066 A.

Firedamp.

Ignition of Firedamp and Coal Dust by Means of Electricity. A report of experiments made to ascertain the danger in using electric appliances in mines. 1500 w. Mines & Min—Aug., 1899. No. 28951 C.

Mine Power.

See Electrical Engineering, Power Applications.

Miners' Pensions.

Old-Age Pensions and Relief Societies for Miners. Extracts from a report of the Labor Department of the Board of Trade, London, giving particulars of schemes in operation for the relief of miners in various countries. 5200 w. Col Guard—Aug. 4, 1899. No. 29077 A.

Mining Plant.

See Electrical Engineering, Generating Stations.

Mining School.

The Camborue Mining School. Interesting information concerning this school and its work. Ill. 1400 w. Engr, Lond—Aug. 4, 1899. No. 29073 A.

Orifice.

Relation Between a Mine's Equivalent Orifice and the Theoretical Thin-Edged Orifice. M. S. Hanappe. From a communication to the Société des Ingenienrs des Mines du Hainaut. Shows the extent of the error committed by identifying these two and gives conclusions reached from calculations and facts given. 2500 w. Col Guard—Aug. 18, 1899. No. 29366 A.

Pumping Engines.

New Underground Pumping Engines for Mines. B. Gerdau, in the *Zeitschrift des Vereines deutscher Ingenieure.* An account of several underground pumping engines recently supplied to deep mines in the Westphalian coalfield and elsewhere. 1400 w. Col Guard—Aug. 4, 1899. No. 29080 A.

Underground Compound Pumping Engine at the Ettes Mine, Hungary (Unterirdischer Compound-Wasserhaltungsmaschine am Ettesar Schachte). Stefan Steuer. A combination pump with Riedler pump valves, and Corliss steam gear for forcing water a height of 220 meters, as used in the Salgo-Tarjan mines in Hungary. 3000 w. 1 plate. Oesterr Zeitsch f Berg u Hüttenwesen—July 15, 1899. No. 29282 B.

Underground Pumping Engine at a Hungarian Colliery. Stefen Steuer. *Oesterr Zeit für Berg und Huttenwesen.* Illustrated description. 1500 w. Col Guard—July 21, 1899. No. 28892 A.

Safety Lamp.

Re-Lighting Marsaut Lamp Fed With Benzine. From a communication by M. Lafitte to the Société de L'Industrie Minérale. Vertical section and details, illustrating this lamp fitted with Seippel re-lighter and adapted for burning benzine. 2000 w. Col Guard—July 28, 1899. No. 28988 A.

Subsidence.

The Effect of Subsidence Due to Coal Workings Upon Bridges and Other Structures. Stanley Robert Kay. Read before the British Inst. of Civ. Engs. The conditions in England which necessitate the construction of expensive structures often where mines have been worked, or exist and the information necessary in designing works in such situations. Full paper and part of discussion. Ill. 7200 w. Col Guard—Aug. 4, 1899. Serial. 1st part. No. 29075 A.

Underground Fires.

The Application of Liquefied Carbonic Acid Gas to Underground Fires. George Spencer. Abstract of a paper in Transactions Federated Inst. of Min. Engs. Reports a successful application to a mine fire, and suggests its value in other emergencies. 850 w. Eng & Min Jour—Aug. 5, 1899. No. 28965.

Ventilation.

Determining the Velocity of Ventilating Air-Currents. P. Fuchs, in *Zeitschrift für Berg-Hutten-und Salinenwesen.* Describes the mode of calculation and illustrates a reliable instrument for carrying out these measurements. 1300 w. Col Guard—Aug. 11, 1899. No. 29153 A.

The Best Arrangement of Ventilators to Enable the Utilization of the Entire Shaft Section (Welche Einrichtung Gestatten bei Oberirdischer Aufstellung des Ventilators den Ganzen Querschnitt eines Förderschachtes zur Wetterführung zu Benutzen). H. Dehnke. With illustrations showing the arrangement of head works to offer the least obstruction to ventilation. 1500 w. 1 plate. Glückauf—July 29, 1899. No. 29281 B.

Winding.

Method for the Supersession of Winding in Shafts. E. Mähnest, in *Glückauf.* Gives a diagrammatic vertical section showing the arrangement, and states the advantages of the method. 1500 w. Col Guard—Aug. 4, 1899. No. 29079 A.

Winding. W. Galloway. A lecture before the South Wales Inst. of Engs. Considers a complete winding outfit for a vertical shaft. Ill. 9500 w. Can Min Rev—July 31, 1899. Serial. 1st part. No. 28902 B.

MISCELLANY.

Alloys

The Alloys of Tin and Lead. Erwin S. Sperry. Results of investigations to determine what combination of these metals produces the strongest alloy for use as soft solder. 1500 w. Foundry—Aug., 1899. No. 29170.

Conglomerates.

Metal-Bearing Conglomerates. Information concerning these deposits which have been found in various places and worked with profit. 1500 w. Min & Sci Pr—July 29, 1899. No. 28919.

High Temperatures.

Later Experience With the Goldschmidt Process for the Production of High Temperatures (Neues über das Goldschmidtsche Verfahren zur Erzeugung Hoher Temperaturen). F. Wüst. Relating experiences with the use of aluminum for the production of high temperatures, giving examples of practical applications. 1800 w. Stahl und Eisen—July 15, 1899. No. 29261 D.

Method of Producing High Temperatures (Verfahren zur Erzeugung Hoher Temperaturen). Dr. H. Goldschmidt. A paper before the German Electrochemical Society giving the further results of the author's method of producing high temperatures by the use of aluminum. 2000 w. Zeitschr für Elektrochemie—July 20, 1899. No. 29276 G.

Kaolin.

The Mining and Preparation of Kaolin. T. C. Hopkins. Abstract of paper in "The Mineral Industry," Vol. VII. Describes methods of mining and washing. Ill. 1400 w. Eng & Min Jour—Aug. 26, 1899. No. 29327.

Lead and Zinc.

The Dubuque Lead and Zinc Mines. H. Foster Bain. Describes the geological position and mode of occurrence of the ores and gives an account of their peculiarities. 3200 w. Mines & Min—Aug., 1899. No. 28950 C.

Lime Rock.

Mining Lime Rock by Electrically-Operated Cableways in Open-Pit Mining at Rockland and Rockport, Maine. Frank B. Knight. Description of the quarries and hoisting plant and a comparison of the earlier and later built cableways, showing the reasons for the greater economy of the latter. Ill. 4000 w. Mines & Min—Aug., 1899. No. 28947 C.

Manganese.

Manganese Mining in Brazil. Information concerning the deposits now being worked, and the manner of working. 1000 w. Eng & Min Jour—Aug. 19, 1899. No. 29132.

Marble Quarries.

Modern Working of the Old Euboean Marble Quarries. Illustrations with a summary of W. Brindley's account of the location and nature of the quarries, and reference to the traditions of the island. 1200 w. Stone—Aug., 1899. No. 29380 C.

Mica.

Mica Mining in Bengal, India. A. Mervyn Smith. Abstract of paper read before the Institution of Mining and Metallurgy, London. Describes the native mines and methods of mining, and the use made of the mineral. 1200 w. Eng & Min Jour—Aug. 26, 1899. No. 29328.

Oil.

Notes on the Oil-Yielding Formations of California. W. L. Watts. A portion of a report to be published by the State Mining Bureau. Information of the value, geological features, depth affected, etc. Ill. 4000 w. Min & Sci Pr—Aug. 5, 1899. Serial. 1st part. No. 29026.

Production.

United States Mineral and Metal Production in 1898. Statistics showing the production of the more important substances to be the greatest on record. 5400 w. Eng & Min Jour—July 29, 1899. No. 28856.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in June. Detailed list and classified summary of 220 accidents, with remarks. 3000 w. R R Gaz—Aug. 11, 1899. No. 29002.

Electricity vs. Steam.

Electricity versus Steam for Branch Railroad Lines. Informal discussion of what are the economic conditions under which electricity may be profitably substituted for steam, and the engineering requirements. 6000 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29306 E.

Fast Runs.

Fast Running by the Pennsylvania Railroad to Atlantic City. Particulars of three runs made by engine known as Class E-1, put in service this year. 500 w. R R Gaz—Aug. 11, 1899. No. 29000.

Fast Run on the London & North-Western. An account of a run made by a special train from London to Crewe and return. 700 w. R R Gaz—Aug. 11, 1899. No. 29003.

Train Service.

The Summer Train Services—British and French. Charles Rous-Marten. Review of improvements and progressive features of the various lines. 4000 w. Engr, Lond—July 28, 1899. No. 28990 A.

Train-Speeds.

The Remarkable Train-Speeds in France. Comment on the speeds attained in France as given in a recent article by Mr. Rous-Marten, and a discussion of their engines as compared with English engines. Ill. 1500 w. Transport—Aug. 11, 1899. No. 29146 A.

FINANCIAL.

Rates.

The Public, the Railroads, and Rate-Cutting. Editorial discussion of the address of Martin A. Knapp at the meeting of railroad commissioners in Denver, Colo. 1800 w. R R Gaz—Aug. 18, 1899. No. 29116.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Lame Maintenance of Air-Brakes. C. F. Sundberg. Giving particulars of how carelessly the air brakes are kept up. 750 w. Loc Engng—Aug., 1899. No. 29191 C.

Wrong Location of the Semaphore Air Gage. Harry A. Flynne. The right and wrong way of placing air-brake gages is illustrated and described. 1000 w. Loc Engng—Sept., 1899. No. 29374 C.

Boiler Tubes.

Locomotive Boiler Tubes. Francis J. Cole, in *The Boiler Maker*. Gives specifications and tests for locomotive boiler tubes, and the requirements of prominent railroads. 1500 w. Prac Engr—Aug. 11, 1899. No. 29332 A.

Coal Car.

Standard Coal Car, 80,000 Lbs. Capacity, Wabash Railroad. Illustrated detailed description of cars in use on this line. 500 w. R R Car Jour—Aug., 1899. No. 28999.

Electric Locomotives.

Applications of Electric Traction on the Paris-Lyons-Mediterranean Railway (Applications de la Traction Electrique sur le Reseau de la Compagnie Paris-Lyon-Mediterranée). With a number of illustrations of electric locomotives operated by storage batteries, charged from hydraulic power plants in the Alps. 2000 w. 1 plate. Génie Civil—July 22, 1899. No. 29201 D.

Freight Cars.

A Point in Freight Car Construction. William J. Knox. Calls attention to the lack of bracing in long cars of great height and width, and thinks many cars now in service are deficient in this particular. Ill. 600 w. Loc Engng—Aug., 1899. No. 28865 C.

Furniture Car.

B. & O. Southwestern New 50-Ft. Furniture Car and Freight Car Truck. General dimensions and illustrated description. 1200 w. R R Gaz—Aug. 11, 1899. No. 29001.

Locomotives.

A Locomotive Boiler With Corrugated Furnace. Sectional views showing the construction of a locomotive running in freight service on the New York Central. 600 w. Eng News—Aug. 24, 1899. No. 29189.

American Locomotives on British Railways. Charles Rous-Marten. Mr. Rous-Marten's third paper contains the expressions of views and opinions of a number of eminent English authorities upon the design and performance of engines built in England and America. 3000 w. Engineering Magazine—Sept., 1899. No. 29296 B.

A Ten-Wheel Express Locomotive in England. J. P. P. Illustration with dimensions and an account of the line over which the engine runs, with facts of interest. 600 w. R R Gaz—Aug. 18, 1899. No. 29114.

Consolidation Locomotives. Gives illustration and chief dimensions of the engines for the Santa Fe Pacific Ry. 400 w. Am Eng & R R Jour—Sept., 1899. No. 29383 C.

Consolidation Locomotives for the Delaware and Hudosn Canal Co. Illustration and general dimensions. 500 w. Ry & Engng Rev—Aug. 5, 1899. No. 28964.

Heavy Ten-Wheel Freight Locomotives for the Union Pacific. Illustrations and dimensions of engines of more than ordinary interest because of their great size. 700 w. R R Gaz—Aug. 25, 1899. No. 29197.

Heavy Ten-Wheel Passenger Locomotive—Denver & Rio Grande Railway. Engraving, half-sectional front end view, general dimensions and particulars. 600 w. Ry & Engng Rev—July 29, 1899. No. 28901.

Heavy Ten-Wheel Passenger Locomotives. Illustration and general dimensions of heavy engines for the New York Central. 400 w. Am Eng & R R Jour—Aug., 1899. No. 28864 C.

Instructions of the Eastern Railroad of France as to Compound Locomotives. Abstract of directions given in the July Bulletin of the International Railroad Congress for the management of compound locomotives. 600 w. R R Gaz—Aug. 4, 1899. No. 28938.

Leverage of the Locomotive Driving Wheel. Illustrated and reasoned out by means of diagrams. 1800 w. Loc Engng—Sept.. 1899. No. 29373 C.

Locomotive for Swedish State Railways. Illustration and general dimensions of twenty six-wheel connected side-tank locomotives built at the Richmond Locomotive and Machine Works. 350 w. Ry & Engng Rev—Aug. 5, 1899. No. 28962.

New Passenger Locomotives of the Pittsburg and Western Railway. Illustration and principal dimensions. 450 w. R R Gaz—Aug. 4, 1899. No. 28937.

Pooling of Locomotives. Jas. S. Martin. Advantages and disadvantages are discussed. 700 W. Loc Engng—Sept., 1899. No. 29370 C.

Six-Coupled Express Engines for Northeastern Railway. Charles Rous-Marten Explains the problem that led to the trial of this new type of locomotive, and describes various runs. Ill. 2500 w. Engr, Lond—July 21, 1899. No. 28885 A.

Six-Coupled Locomotive, Cauca Railway, United States of Colombia. Illustrations, principal dimensions and specifications, with particulars. 700 w. Ry & Engng Rev—Aug. 12, 1899. No. 29081.

Ten-Wheel Freight Locomotive, Union Pacific Railway. Illustration and general specifications. 600 w. Ry & Engng Rev—Aug. 12, 1899. No. 29082.

The Weight of Locomotive Engines. Editorial on the factors that determine the weight. 1500 w. Engr, Lond—Aug. 11, 1899. No. 29161 A.

Tire Wear of Locomotives. Thomas P. Whelan. Describes causes of uneven wear. 2000 w. Loc Engng—Sept., 1899. No. 29371 C.

Two Improvements in Compound Locomotives. Illustrates and describes the improvement in the Allen valve and in by-pass valves for low-pressure cylinders. 1700 w. Am Eng & R R Jour—Sept., 1899. No. 29384 C.

Wide Firebox Consolidation Loco-

motives. Illustration and chief dimensions of locomotives for the Delaware & Hudson Co., for burning anthracite coal. 700 w. Am Eng & R R Jour—Aug., 1899. No. 28863 C.

Smokeless Firing.

Smokeless Firing With Bituminous Coal on Passenger Trains. W. J. Murphy. Gives a copy of the instructions for firing passenger locomotives on the Queen & Crescent to prevent smoke. Ill. 1100 w. Loc Engng—Aug., 1899. No. 28867 C.

Steel Car.

Special Steel Car for Transporting Heavy Loads; North Belgian Railway. Illustrated detailed description of a special car of interest as showing French methods in car construction. 1100 w. Eng News—Aug. 17, 1899. No. 29100.

Valves.

The Intercepting Valve of the Schenectady Compound. C. R. Petrie. Describes this valve and explains its use and operation. 2200 w. Loc Engng—Aug., 1899. No. 28866 C.

NEW PROJECTS.

Arctic Railway.

The Making of an Arctic Railway. Abstract of an article in a recent number of *Aftonbladet*. Interesting details of the railway in course of construction from Gellivara to Victoriahavn in Norway. 1200 w. Ir & Coal Trds Rev—July 21, 1899. No. 28875 A.

Asia.

The Railways of Asia (Les Chemins de Fer de l'Asie). A general description of the present railway systems of Asia, and a discussion of lines projected and under construction. 3500 w. 1 plate. Rev Gen de Chem de Fer—July, 1899. No. 29236 F.

Ecuador.

The Proposed Guayaquil & Quito Railway in Ecuador. Illustrates and describes some of the principal features of this road. 1100 w. Eng News—Aug. 17, 1899. No. 29098.

England.

The London and North-Western's New Route to Buxton and Manchester. Describes a trip over the new line, the country through which the line passes, and some of the features. Ill. 1800 w. Transport—Aug. 4, 1899. No. 29058 A.

Euphrates Valley.

The Euphrates Valley Railway. Editorial review of the various projects during the last sixty years for constructing a line of railway in this valley, and showing the importance from a trade point of view, and as a connection between England and India. 1500 w. Engr, Lond—Aug. 18, 1899. No. 29355 A.

India.

The Railways of India. Information from the Administration Report for the year ending March 31, 1899. 3000 w. Ind & East Engr—July, 1899. No. 29-142 D.

Nicaragua.

The Masaya-Diriamba Railway of Nicaragua. Illustrated description of a recently constructed branch railway from Masaya to Diriamba, which opens one of the most picturesque parts of this country. 1200 w. Eng News—Aug. 10, 1899. No. 29005.

Siberian.

The Western Lines of the Siberian Railway (Die Westlinie der Sibirischen Eisenbahn). A review of the progress and operation of the Siberian railway from Tscheljabinsk to Irkutsk, with a good map showing the entire Trans-Siberian system, and data as to cost. Two articles. 1 plate. 6000 w. Glaser's Annalen—Aug. 1, 15, 1899. No. 29249 each D.

The Trans-Siberian Railroad. Henry Michelsen. An illustrated abstract and the full article without illustrations. 4500 w. Sci Am & Sc Am Sup—Aug 26, 1899. No. 29180.

The Trans-Siberian Railway. William Durban. A general survey of this line and its excellent construction, with remarks on its future possibilities and the effect it is to have on Siberia and the world in general. 5800 w. Contemporary Rev—Aug., 1899. No. 29085 D.

Uganda.

The Uganda Railway. An account of the line and the progress made, which has been very slow because of the great difficulties. Maps. 2500 w. Engng—Aug. 11, 1899. No. 29164 A.

PERMANENT WAY AND BUILDINGS.

Displacement.

Two Unusual Instances of Railway Track Displaced by Ocean Waves. Illustrates a case on the Nantucket Branch of the New York, New Haven and Hartford, and one on the Old Colony R. R. 450 w. Eng News—Aug. 24, 1899. No. 29185.

Railway Development.

Railway Development Still Continues. Editorial showing that the demand for railway material in the United States is

in no danger of becoming of small importance. The mere replacement requires a large production; the building of side tracks, second tracks, etc., and improvements in roads all make large demands. 1600 w. Ir Age—Aug. 17, 1899. No. 29096.

Roundhouses.

Types of Russian Roundhouses. Illustrations of different types of enginehouses reproduced from the *Aperçu des Chemins de Fer Russes*, with brief description. 300 w. Ry Age—Aug. 11, 1899. No. 29049.

Station.

Coal, Ash and Sand-Handling Station —Illinois Central Railway, 27th Street Shops, Chicago. Illustrates and describes a station that has been in successful operation since January 1, serving about 100 locomotives a day. 1000 w. Ry & Engng Rev. July 29, 1899. No. 28900.

Ties.

Portable Plant for the Preservative Treatment of Railway Ties. Illustrates and describes a plant that may be hauled to any desired point and set up on temporary side tracks. 1400 w. Eng News —Aug. 17, 1899. No. 29105.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Discussion of paper by Walter W. Curtis. 7500 w. Pro Am Soc of Civ Engs —Aug., 1899. No. 29309 E.

Track in Tunnels.

Comparative Advantages of Ballasted Cross Ties and Unballasted Longitudinals for Railway Track in Tunnels. Jules Michel, in *Revue Generale des Chemins de Fer.* Abstract translation of this article which discusses the comparative advantages and cost. 900 w. Eng News—Aug. 10, 1899. No. 29006.

Washout.

The High-Water Damage to the Melk Section of the State Railways in 1897 (Die Hochwasserschäden des Jahres, 1897, im Bezirke der k. k. Bahnerhaltungs-Section Melk). R. Ziffer. A description of the nature of a number of washouts on the Austrian Railways and an account of the repair work. Two plates. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1899. No. 29251 D.

Water Stations.

Russian Water Stations. Illustrated description of the various sources of supply and the construction of water stations. Translated from the "Apercu des Chemins de Fer Russes." 1300 w. Ry Age—Aug. 18, 1899. No. 29141.

TRAFFIC.

Africa.

Statistics of the Railways of Algeria and Tunis (Statistique des Chemins de Fer Algériens et Tunisiens). The official report of the operations of the French railways in Northern Africa. 2000 w. Rev Gen de Chem de Fer—July, 1899. No. 29235 F.

Freight Methods.

Reforms in Freight Methods. J. W. Midgley. Notes some reforms which have been made and others which should be brought about. 2000 w. Ry Age—Aug. 11, 1899. No. 29048.

Mineral Traffic.

Railway Traffic During 1898. Statistics of traffic on roads of Great Britain, with special reference to the transportation of minerals. 2000 w. Col Guard—Aug. 11, 1899. No. 29154 A.

STREET AND ELECTRIC TRAMWAYS

Blackpool, Eng.

The Trolley Problem at Blackpool. An account of how the trolley has supplanted a conduit system, with illustrated description of the road. 1300 w. Elect'n, Lond—July 28, 1899. No. 28978 A.

Brake.

Brake System for Electric Cars and Trains (Bremsung Elektrisch Betriebener Wagen und Züge). Max Schiemann. A paper before the Berlin Electrotechnical Society describing an improved form of magnetic brake acting at the same time upon the rails and the wheels. 6000 w. Elektrotech Zeitschr—July 27, 1899. No. 29271 B.

Dudley and Stourbridge.

The Dudley and Stourbridge Electric Tramways. An illustrated account of a reconstructed line formerly a steam tramway. 2800 w. Elec Rev, Lond—July 28, 1899. No. 28981 A.

Düsseldorf.

High Speed Electric Railway Between Düsseldorf and Krefeld. An illustrated account of this road in Germany, the first installation of a high-speed elec-

tric railway in Europe. 2400 w. St Ry Jour—Aug., 1899. No. 28906 D.

Electrolysis.

Electrolysis at Kansas City, Kan. Illustrated statement of investigations by L. I. Blake showing internal as well as external corrosion of water pipes. 4200 w. Eng Rec—Aug. 12, 1899. No. 29034.

Extensions.

Extensions of the Lake Street Elevated Railroad. An account of some important extensions in Chicago. Ill. 800 w. W Elect'n—Aug. 12, 1899. No. 29045.

Florence, Italy.

The Electric Tramways of Florence. Illustrates and describes the present system and gives numerous views along the lines. 1700 w. Ry Wld—Aug. 10, 1899 No. 29350 A.

Gas Power.

Gas Tram Cars. Illustrates and describes these cars and the recent improvements made. 800 w. Engr, Lond—July 28, 1899. No. 28991 A.

Glasgow.

Glasgow Tramway Results. A report of the interesting and gratifying financial results of this very successful municipal undertaking. 1200 w. Engng—Aug. 4, 1899. No. 29070 A.

Hull, Eng.

Hull Corporation Electric Tramways Illustrates and describes the transformation being effected in the tramway facilities. 8000 w. Ry Wld—Aug. 10, 1899. No. 29349 A.

Hull Corporation Electric Tramways. Historical notes with illustrated description of the line and power station. 3000 w. Elect'n, Lond—July 28, 1899. No. 28979 A.

Light Railways.

A New Tramway Monopoly. Robert Donald. A discussion of the Light Railways Act of 1896, and the way in which it has miscarried. 2400 w. Contemporary Rev—Aug., 1899. No. 29084 D.

London Traction.

The London County Council and Electric Traction. Full text of the report of A. B. W. Kennedy to the Committee on mechanical traction on tramways. 4500 w. Elect'n, Lond—Aug. 18, 1899. No. 29347 A.

Maine.

A Model American Electric Railway System. Illustrates and describes the Lewiston, Brunswick and Bath Street Railway in the state of Maine. 2500 w. Engng—Aug. 18, 1899. No. 29359 A.

Multiple Unit.

The Multiple-Unit System of Electric Railways. Frank J. Sprague. Describes the system, and its illustration in the South Side Elevated Railway of Chicago. Discussion and appendix. Ill. Full paper. 31500 w. Trans Am Inst of Elec Engs—May, 1899. No. 29057 D.

Paris.

The Application of Mechanical Traction to the Lines from the Louvre to Vincennes (Application de la Traction Mecanique aux Lignes du Louvre à Vincennes). A. Monmerqué. A description of the accumulator electric traction system now being installed on an important section of the Paris tramways. 6000 w. Rev Gen de Chem de Fer —July, 1899. No. 29233 F.

Pittsburg.

Some Electrical Features of the Power Station of the Consolidated Traction Company of Pittsburg. Details of interest in regard to station equipment are described, a number of them differing from standard practice. Ill. 900 w. St Ry Jour—Aug., 1899. No. 28904 D.

Popp System.

Popp Compressed Air Motors for Tramway Traction. Illustrated description of this system, with a statement of its advantages. 2000 w. Compressed Air—Aug., 1899. No. 28893.

Quebec, Canada.

The Electric Railway Systems of Quebec, Canada. Illustrated detailed description of the route, the difficulties, service, equipment, construction, etc. 4000 w. St Ry Jour—Aug., 1899. No. 28903 D.

Receipts.

Comparative Gross Receipts of American Street Railway Companies. A table of comparative gross receipts of 222 American street railway companies for financial years ending in 1897 and 1898. 2000 w. St Ry Jour—Aug., 1899. No. 28905 D.

Richmond, Va.

The Richmond Traction Co., Richmond, Va. Illustrates and describes the single trolley system used and the equipment of the road, management, etc. 2800 w. St Ry Rev—Aug. 15, 1899. No. 29-111 C.

Surface Contact.

The "Diatto" Surface-Contact System on Tramways at Tours. Illustrated detailed description. 2000 w. Ry Wld—Aug. 10, 1899. No. 29351 A.

Westphalia.

The Markisch Tramway System (Die Märkische Strassenbahn). Max Schiemann. An illustrated description of a suburban overhead-trolley line connecting a number of towns in the Arnsberg district of Westphalia; with details of the operation. 3000 w. Elektrotechnische Zeitschr—July 20, 1899. No. 29268 B

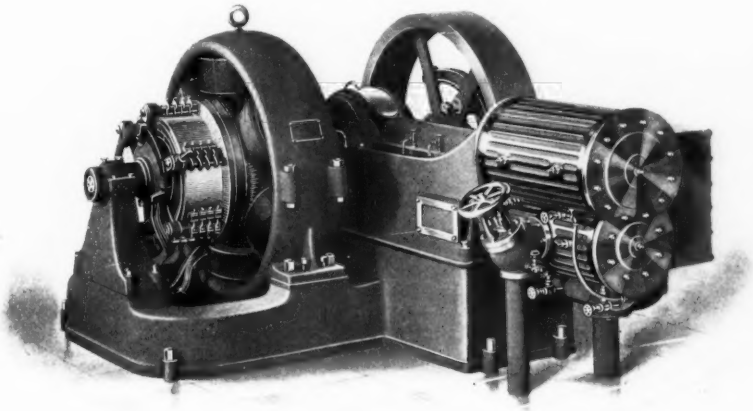
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A New Engine.

THE illustration shown herewith will be recognized as a new departure in steam engineering. The most conspicuous feature of this engine is its compactness, as it will be observed that no more floor space is required than for a simple engine. It is notable that both pistons are as accessible for inspection as with the simple engine, which is a strong point in its favor when compared with the tandem compound. The



extreme simplicity of this engine is as remarkable as its compactness. A single valve and valve gear control the steam distribution of both cylinders and the single steam chest connecting them furnishes the necessary receiver. The arrangement of pistons and cross-head is peculiar to this engine. The length of the latter is equal to about twice the length of stroke of the engine, so that its smoothness of running is quite independent of any unequal division of work between the pistons, if such should occur; but because of the simultaneous cut-offs in both cylinders the work is divided almost exactly between the two pistons at all stages of load, from the simple friction load to the fullest overload capacity. This engine is adapted especially to direct connection to an electric generator, and the builders, the American Engine Co., Bound Brook, N. J., will be glad to furnish further particulars upon request.

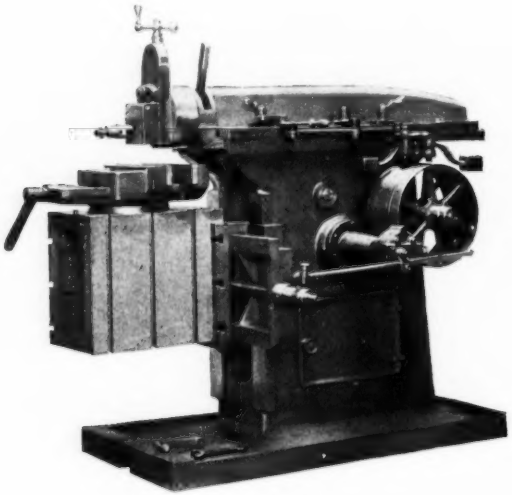
Back Geared Shaper.

WE give an engraving of an improved shaper which, although it conforms in general to the standard designs, possesses some new features of interest. So far as

the photograph indicates, it is a shaper of the usual pillar and slotted lever type, but of somewhat unusually heavy proportions, designed to give it rigidity and strength, and it will be noticed that the slide in which the ram works is extended both front and back to give great length of bearing. An opening is provided through the column below the ram, which permits long work up to 3 inches diameter being passed through the machine.

The gearing of this shaper is its chief novelty, the main gear carrying on its face the movable crank-pin and block. This is in the photograph, and above it is a removable cover which permits access to the gearing for inspection and oiling.

The position of the ram is changed by the rotation of a screw, the squared end of which projects from the rear end of the ram, and the stroke is changed by turning the hand wheel seen on the working side of the machine, this having clutch teeth which are released by the action of the spring when the knurled disk is loosened, and the wheel is then free to be turned to any desired position, graduations on the hub of the wheel and the upper feed gear



driven by engagement with a pinion which for light work and short strokes, is driven directly by a loose spur gear, which in turn is driven by clutch teeth formed on its side and which engage with similar teeth formed on the side of the sliding splined pinion. When, however, heavier cutting or long strokes are to be taken, the pinion is moved to the right, disengaging the clutch teeth and sliding the pinion itself into engagement with the spur wheel, thus increasing the ratio of the gearing and giving four additional speeds.

This movement of the pinion clutch is effected from the rear of the machine by a lever, which, however, does not show indicating the length of stroke to which the machine is set.

There is a ball thurst bearing on the screw for lifting the cross-slide and knee, and all traversing screws are graduated. The machine shown is called the 16-inch shaper and has an extreme stroke of 16½ inches; vertical travel of table of 16 inches; horizontal movement of table, 21½ inches; feed of head at any angle, 6¼ inches; bearing of the ram in column, 29 inches long by 10½ inches wide, and complete weight 2,200 pounds. It is made by the Cincinnati Shaper Company, Cincinnati, Ohio, who will furnish additional information and catalogues on request.

The Toerring Long-Burning Arc Lamp.

PRACTICALLY the only cause of the revolution in arc lighting by which the enclosed lamp is driving out the older form of open arc is due to the reduced consumption of carbon and consequent lower cost of trimming. It is, therefore, manifest that a gain in this direction, other factors remaining the same, is a valuable advance.

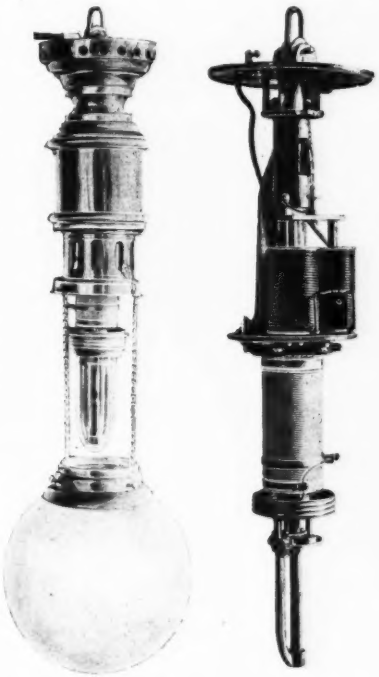
The reduced carbon consumption is gained by checking the access of oxygen to the arc. In the ordinary enclosing globe there is some leakage of the gases around the bottle cap, which cannot be of one piece fastened hermetically to the globe, since it must be free to move laterally in order to prevent it from binding the carbon and there must be some clearance around the carbon to allow the passage of irregularities through the opening. In many forms the lower carbon comes through the bottom of the globe, giving some chance for leakage at that point. As this leakage is reduced, the life of the carbon becomes longer.

In the new lamp illustrated herewith a novel arrangement of the parts is made to minimize the circulation of air into and out from the inner globe. In the first place, as in some previous lamps, the negative or lower carbon holder is brought down within the globe, doing away with an opening at the bottom. The chief novelty lies in the fact that the bottle cap is made a part of a long cylinder or tube which is air tight and encloses the whole of the upper carbon. The arc enclosure thus consists of the transparent inner globe fastened tightly to the lower end of this cylinder, both carbons being entirely within the enclosure.

Another factor that tends to improve arc economy is the high temperature of the inner globe, the light emitted being dependent upon the temperature of the arc, which temperature is maintained under reduced heat dissipation with a corresponding reduction of the power consumed. As most of the heat from the arc rises and is conducted away by the metallic upper portion of the enclosing chamber, this is in the Toerring lamp simply surrounded by the series resistance so as to keep it hot.

By these means the carbon consumption is claimed to be greatly reduced, the maker guaranteeing the lamp to burn 200 hours under ordinary conditions with 12 ins. of carbon, the arc being adjusted to about 85 volts, and claiming that it has burned under the same conditions over 300 hours.

The means of trimming and adjusting the lamp will also appeal to those who use it. With the inner globe removed the upper carbon is simply pushed up through the lower carbon holder and the clutch



and into the sheath which encloses and carries current to it. The negative carbon is pushed in after it and is simply broken off with plyers if it protrudes below the holder, no measurement or cutting to gage being necessary.

The brass threaded spinning which holds the inner globe to the cylinder forming the upper part of the enclosure is readily removable with the inner globe, so that the lamp may be trimmed when hot.

By simply lowering the outer globe as shown in the illustration, the resistance becomes accessible.

The rheostat consists of a high resistance wire laid in a helical groove formed on the surface of a porcelain cylinder. This construction adds to the heat radiating surface and permanently holds and separates each turn of the wire on a fireproof structure. The resistance is changed by clamping a strap about the cylinder, and in contact with the wire at any desired position.

The construction of the regulating mechanism is entirely of fire-proof materials. The clutch is located within the enclosing globe and operated by a double magnet pulling downwardly on an armature attached to a chain running over a small pulley.

The lamp is short, measuring 26 ins. over all and weighing about 18 lbs. with the globe. It is made for 110 and 220 volt direct current circuits, a 500 volt and series lamp being in course of development.

The makers of the lamp, the C. J. Toerring Company, of Philadelphia, will give full particulars about this lamp, especially to manufacturers whose works need lighting.

Portland Cement for Marine Work

SEVERAL months ago a review was made in THE ENGINEERING MAGAZINE of some Austrian experiments upon the behavior of cements when exposed to the action of sea water, and it was shown that in some instances cements otherwise of high resisting power became rapidly disintegrated when exposed to the influence of the sea. The remedy was shown to lie in the prevention of the presence of free lime, which could be accomplished by the admixture of puzzolana or similar material.

It is now announced that Mr. H. J. Livingston, of Baltimore, Md., proposes to render Portland cement capable of resisting the action of sea water by adding to it a mixture of carbon, hydrocarbon and slaked lime. While a very large proportion of lime hydrate can be added, even up to 125 per cent., without diminishing its hydraulicity, it is found that from fifteen to twenty-five per cent. gives the best results. It is claimed that under Mr. Livingston's treatment a slow setting cement, free from cracking, is produced, and that it is very plastic and adhesive, and especially well adapted for use in marine structures owing to its capacity for resisting the disintegrating action of sea water.